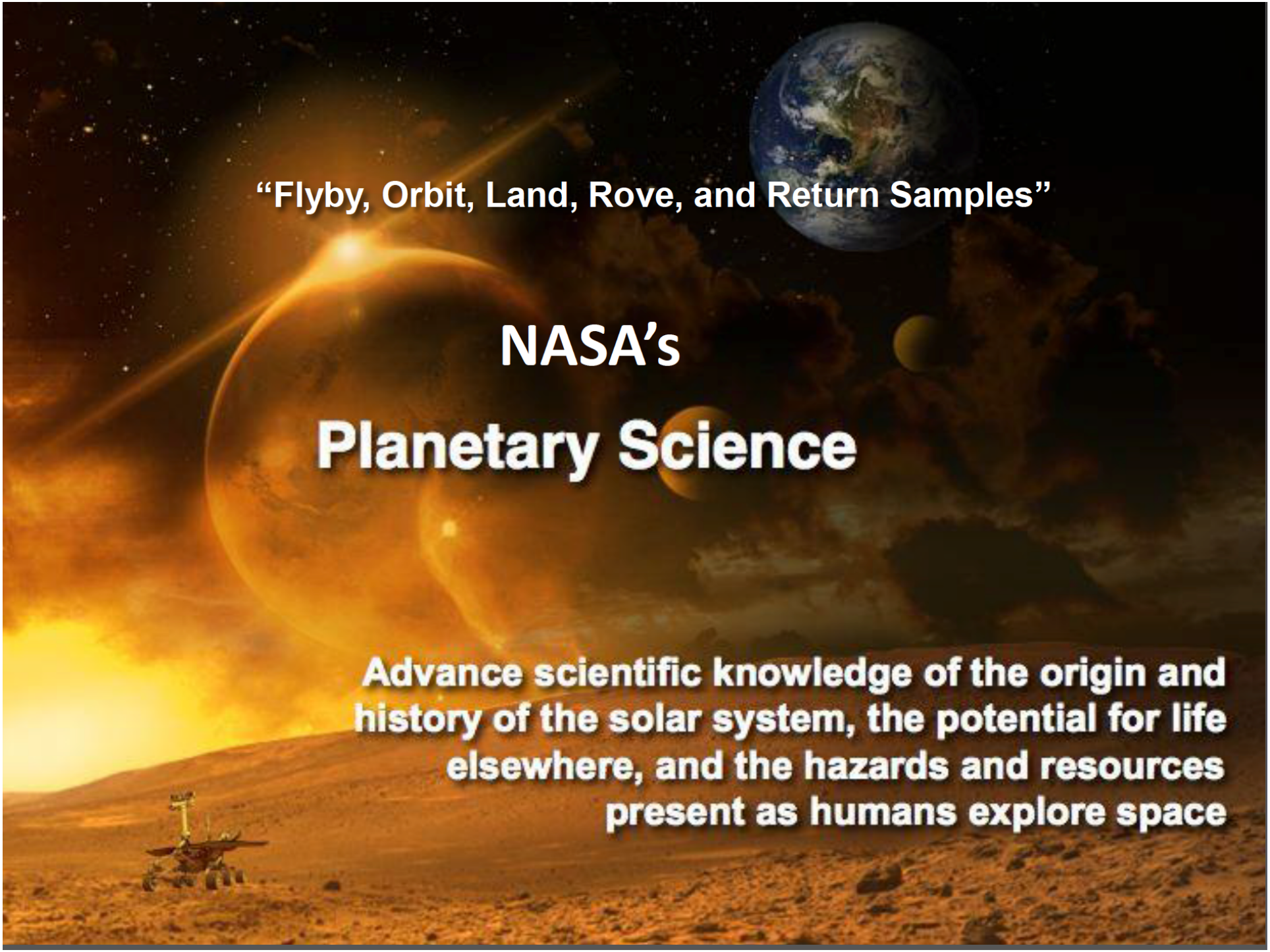
Welcome to

Presented by NASA's Discovery and New Frontiers Programs

March 7, 2015

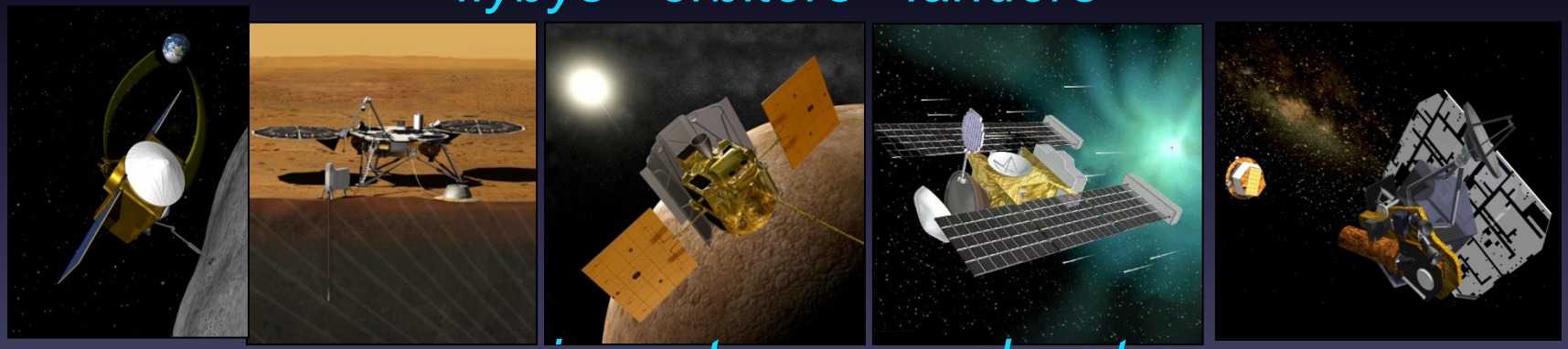

"Flyby, Orbit, Land, Rove, and Return Samples"
NASA's
Planetary Science
Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space

NASA's Discovery and New Frontiers Programs

- Lower-cost planetary science missions searching for answers
- Revolutionizing perceptions and challenging long-held theories with amazing new images, data and samples
- Proposed by a "Principal Investigator" along with a large team of scientists and engineers
- People with lots of questions, on a quest for new knowledge
- Looking for new innovative ways to explore

Exploring planets, moons, asteroids & comets

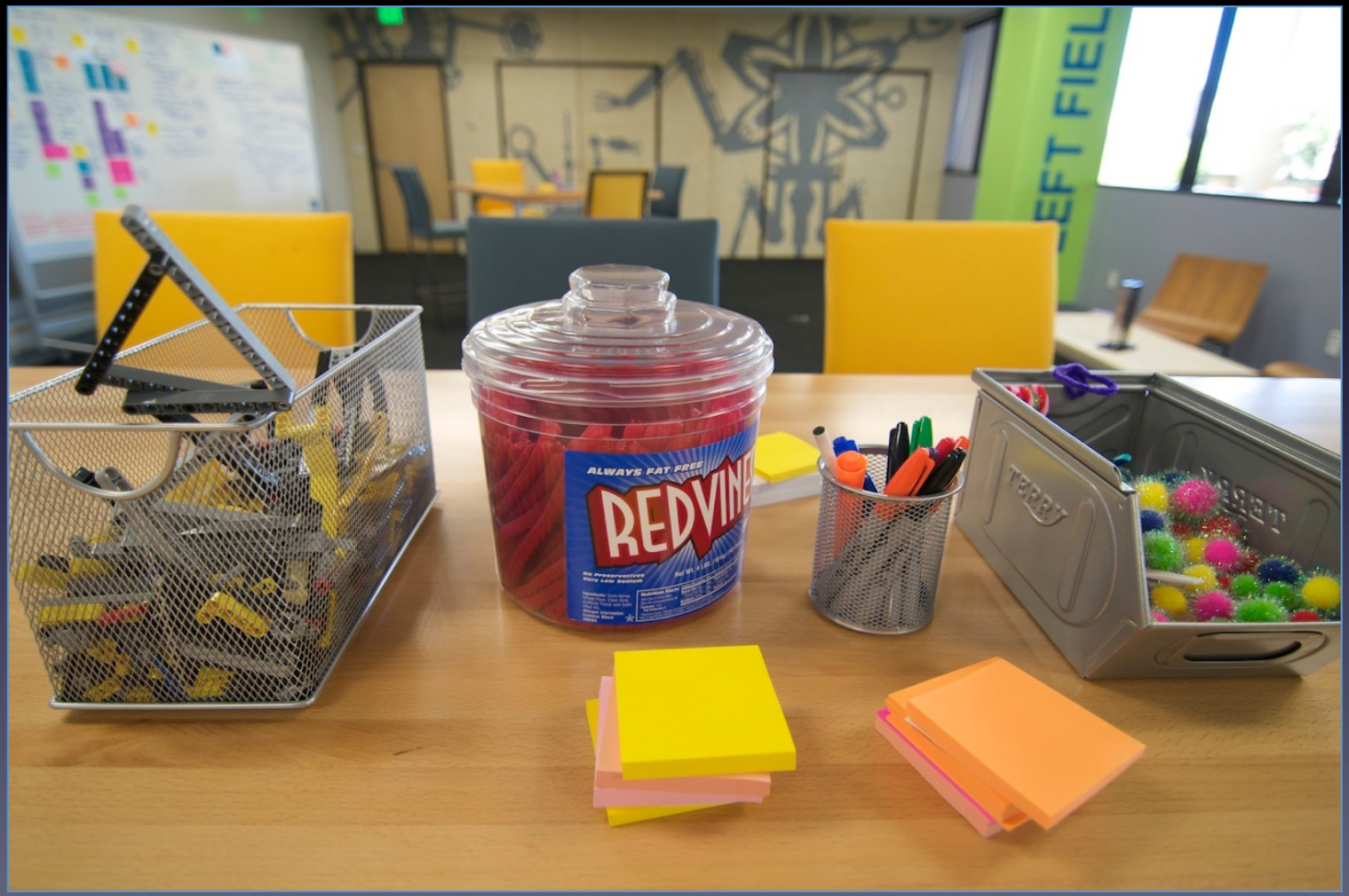
flybys • orbiters • landers



rovers • impactors • sample returns

Creative Mission Design

How would you design your dream mission?

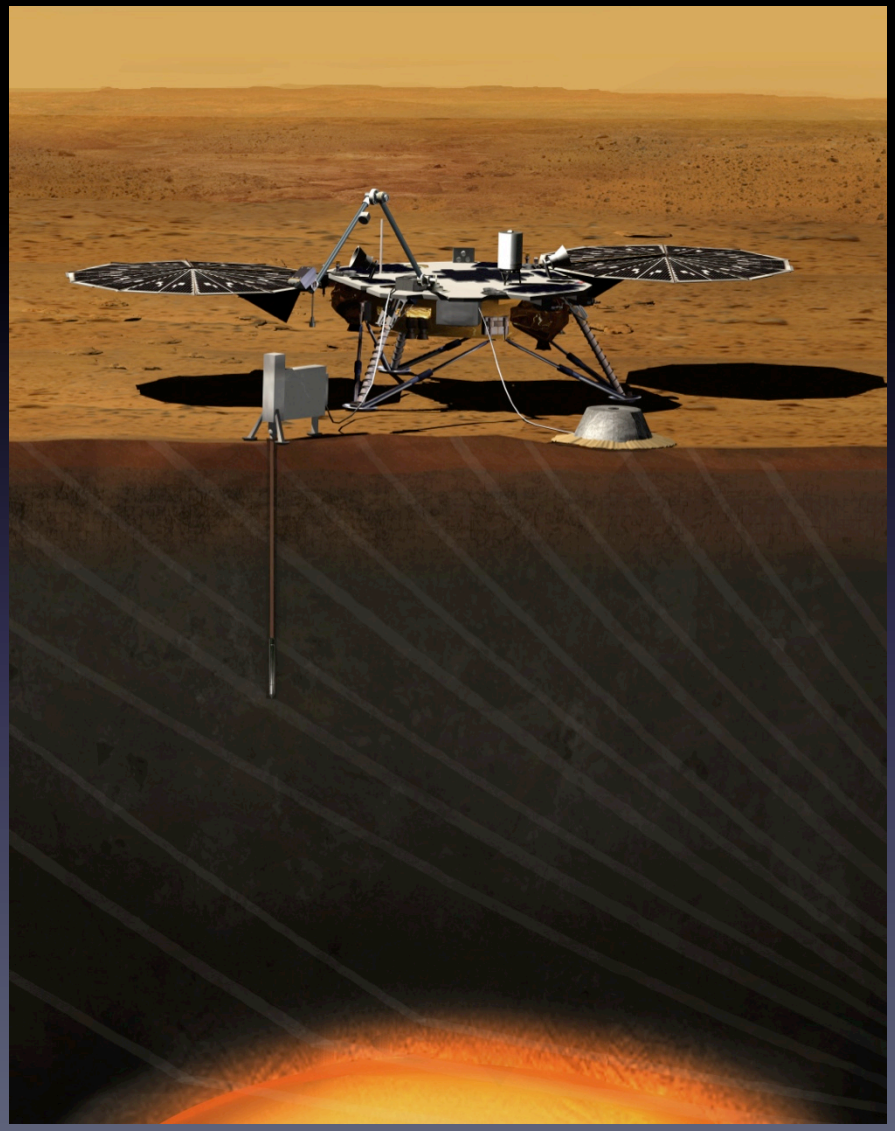


Out in Left Field

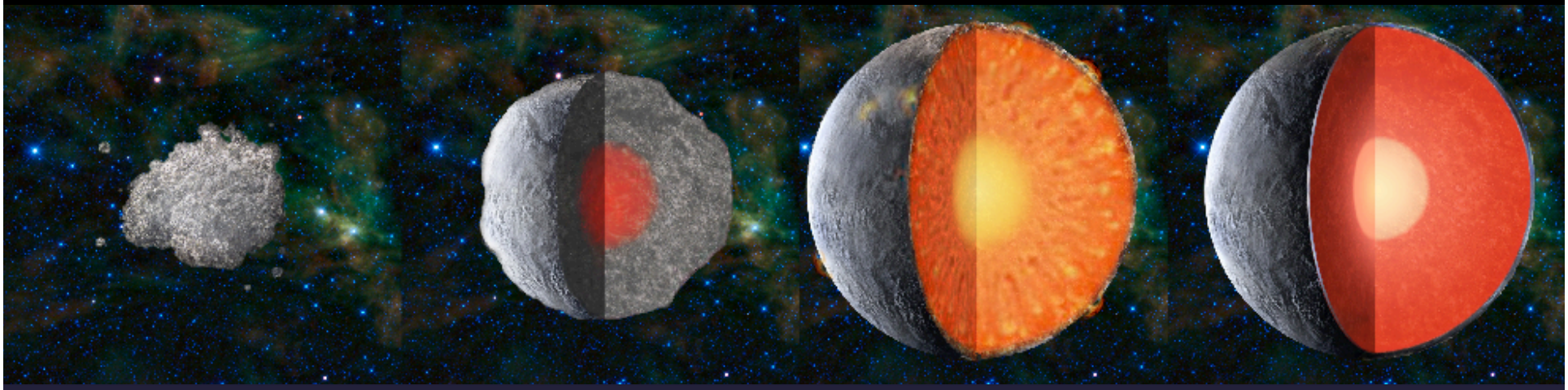
InSight into Mars Quakes!

Interior Exploration using Seismic Investigations, Geodesy and Heat Transport

- Will place a geophysical lander on Mars to study its deep interior
- **InSight** into the processes that shaped the formation of the rocky planets of the inner solar system
- Launch March 2016
- Arrival at Mars 6 months later
- Two years of science operations



How Does a Terrestrial Planet Form?



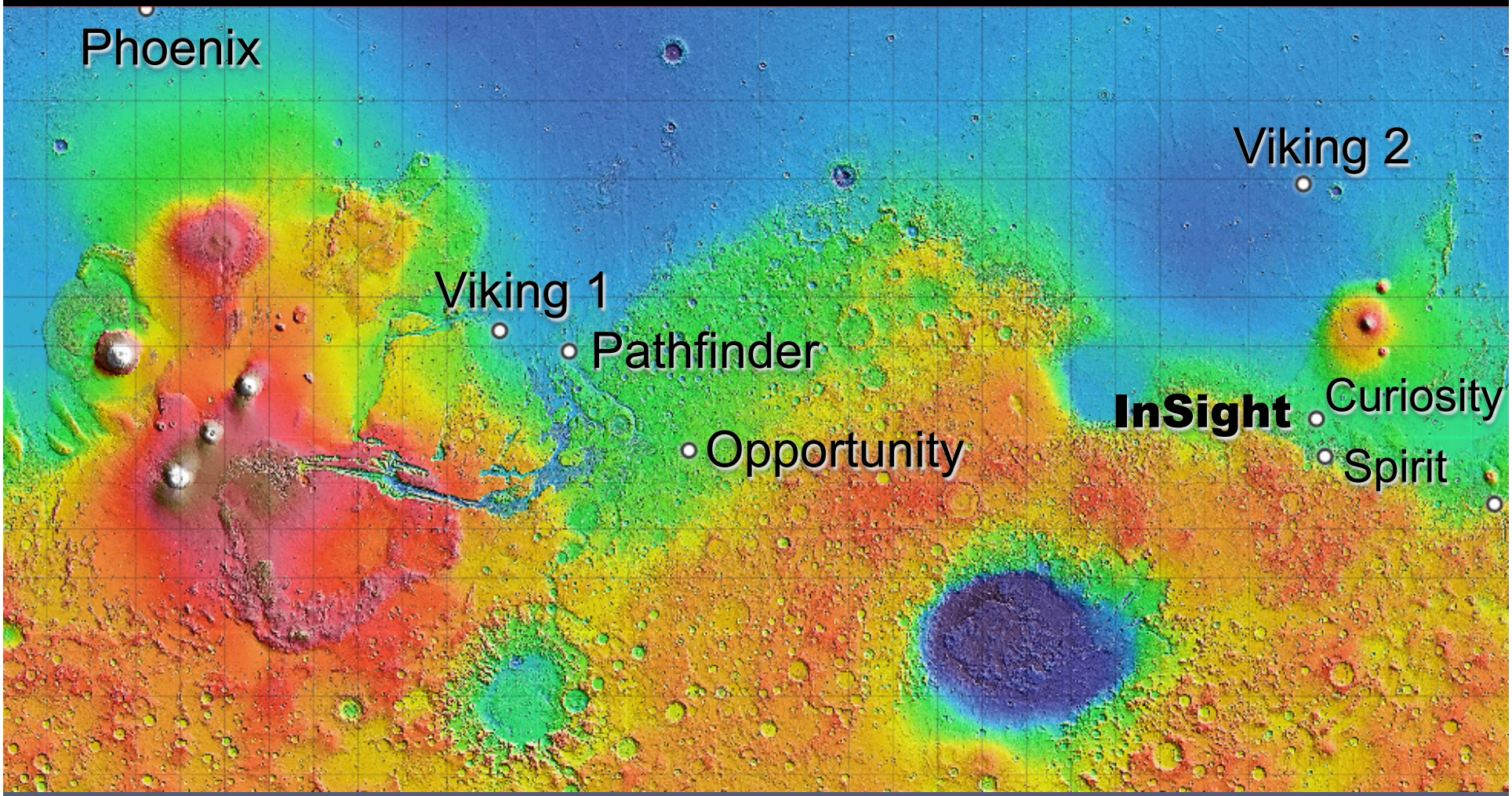
A Rocky Body Forms and Differentiates

- The planet starts forming through accretion.
- As it gets bigger, the interior begins to heat up.
- Stuff happens… this is where InSight will help fill in the gap!
- End up with a crust, mantle, core

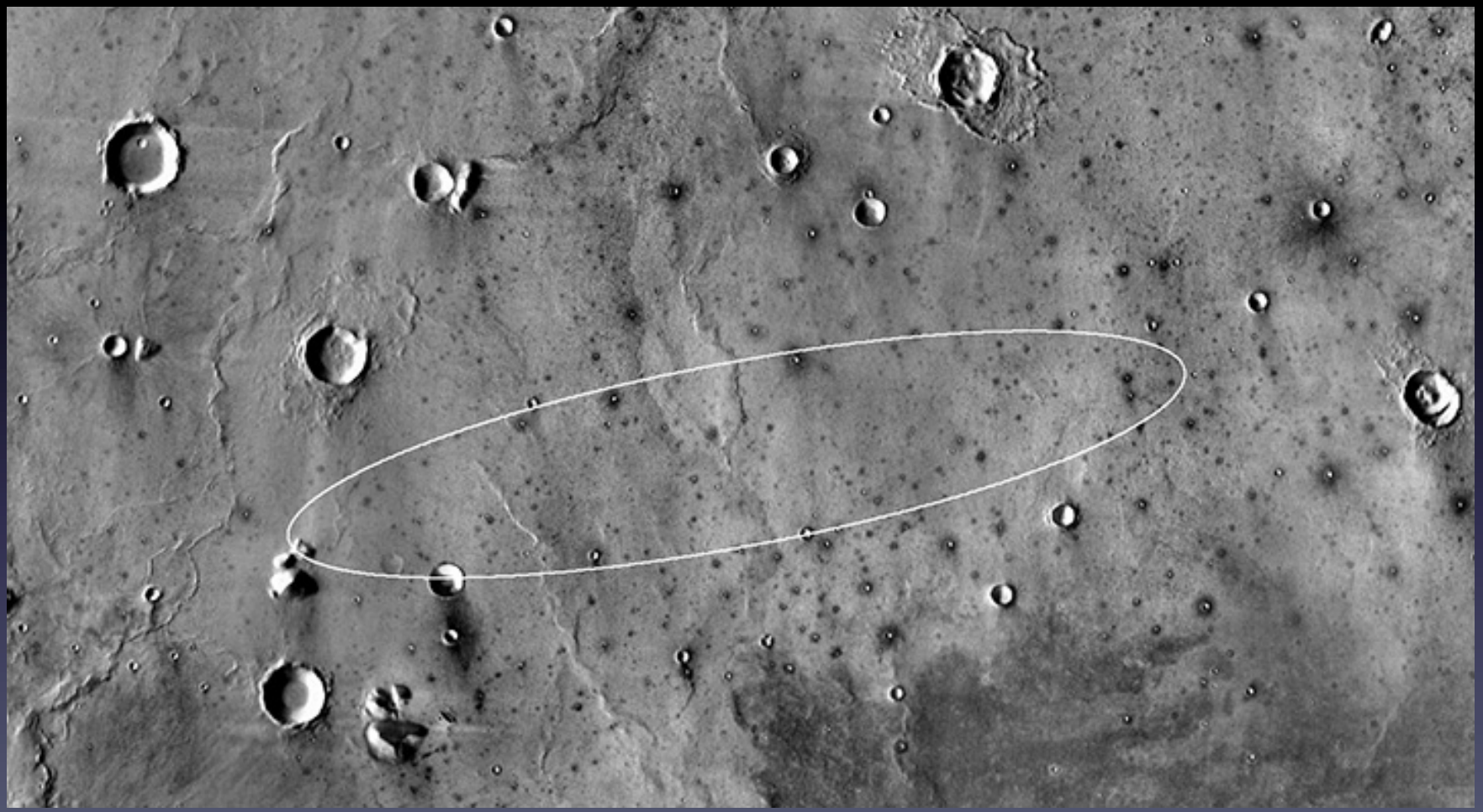
Science Objectives

- Investigate the interior structure and processes of Mars to determine
  - size, composition, physical state (liquid/solid) of the core
  - thickness and structure of the crust
  - composition and structure of the mantle
  - thermal state of the interior
- Determine the current level of tectonic activity and meteorite impact rate on Mars

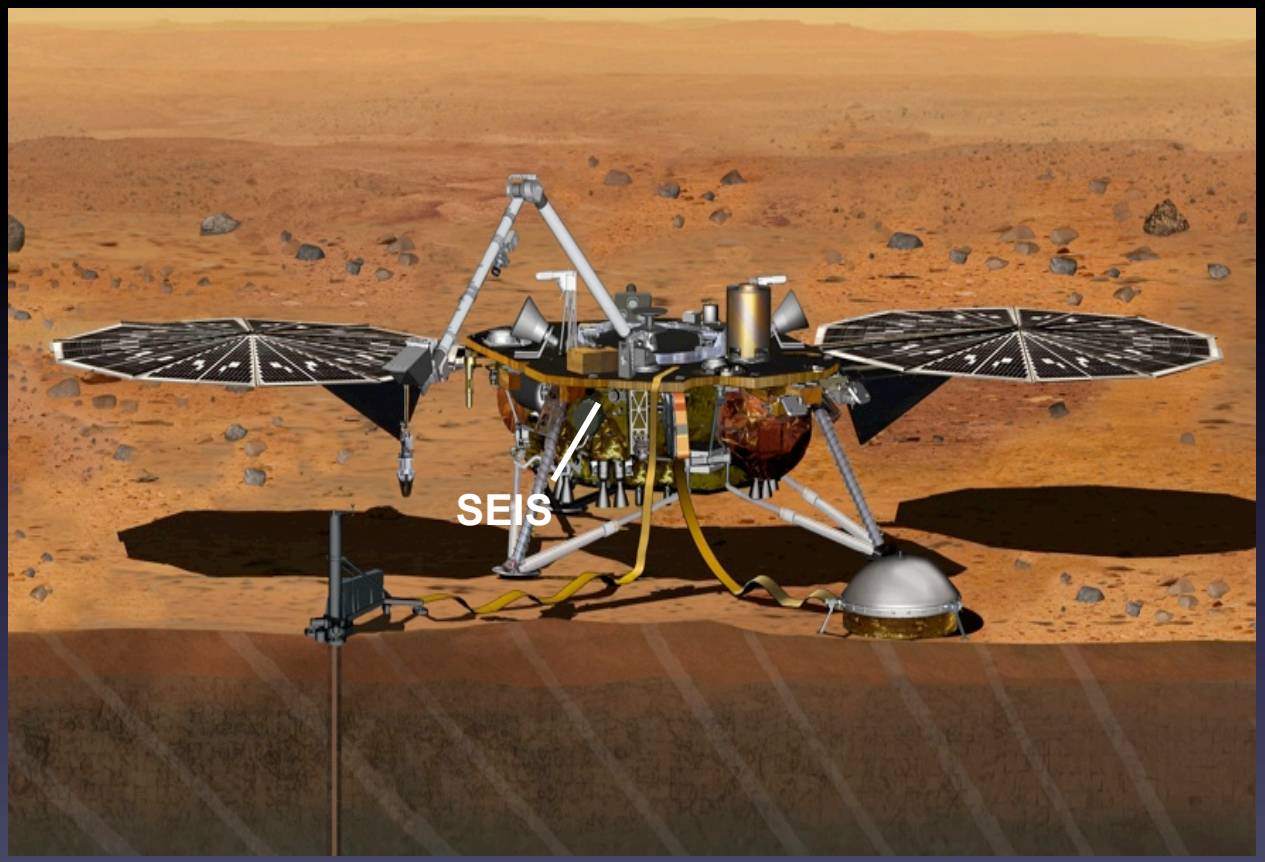
Landing Region



One Site Identified - Smooth, Flat, Not Rocky



SEIS (Seismic Experiment for Interior Structure)

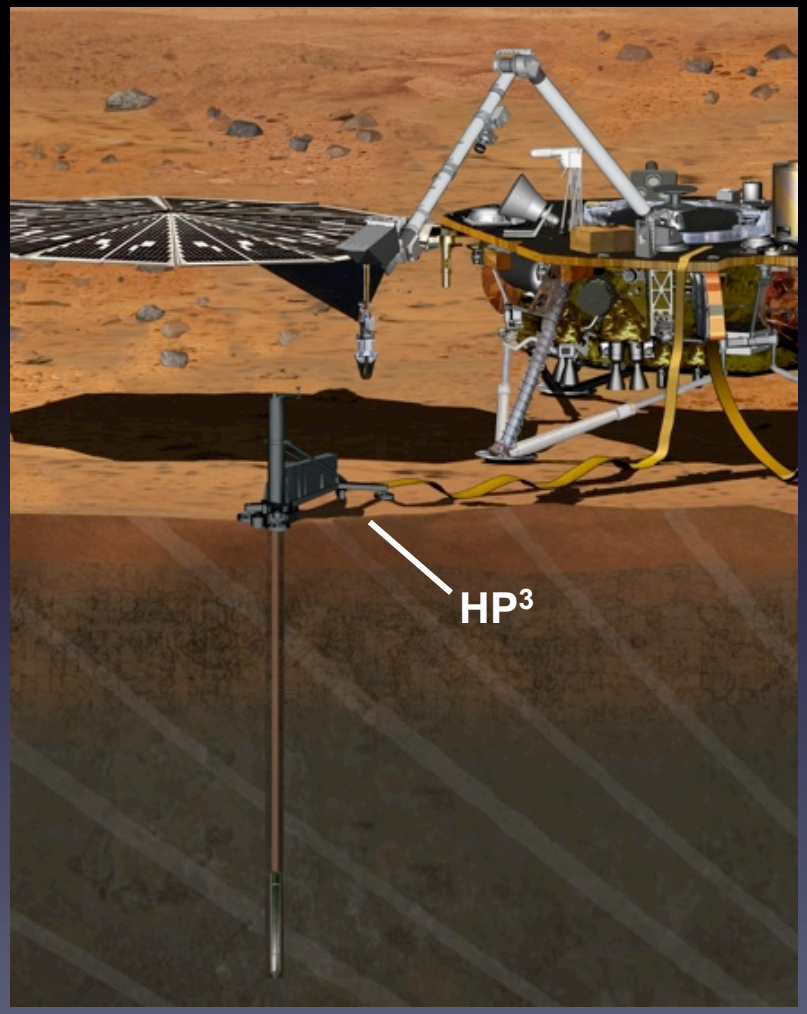


To capture Mars' pulse – its internal activity – InSight will carry a seismometer to take precise measurements of quakes and other internal activity on Mars to better understand the planet's history and structure.

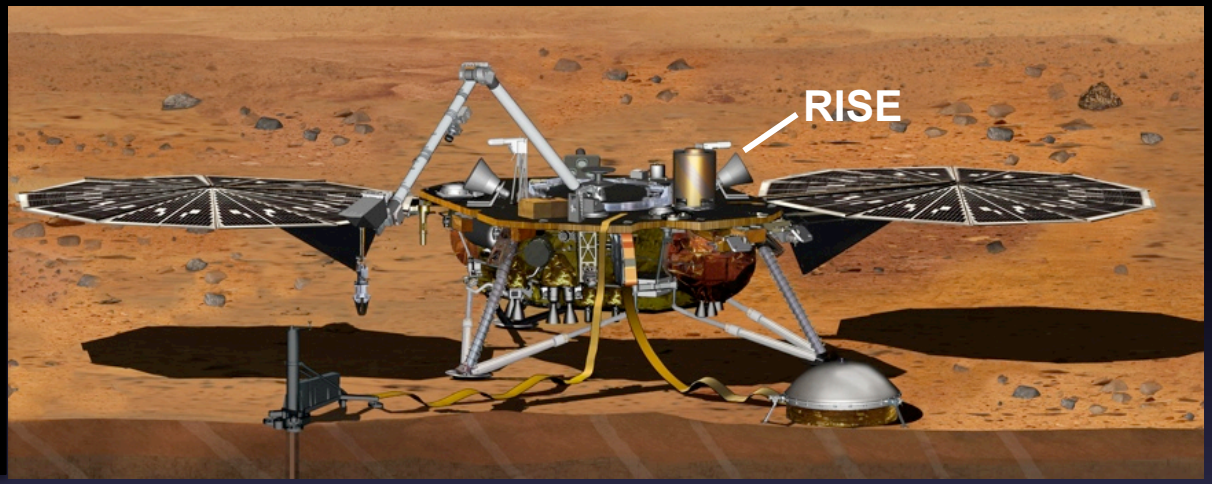
HP^3 (Heat Flow and Physical Properties Probe)

Will take Mars' temperature, a key indicator of planetary evolution

The probe will burrow down to 5 meters below the surface to learn how much heat is coming from Mars' interior and reveal the planet's thermal history



RISE (Rotation and Interior Structure Experiment)



Tracks Mars' reflexes, or the way it wobbles when it is pulled by the Sun

RISE will precisely measure the Doppler shift and ranging of radio communications sent between the InSight lander and Earth

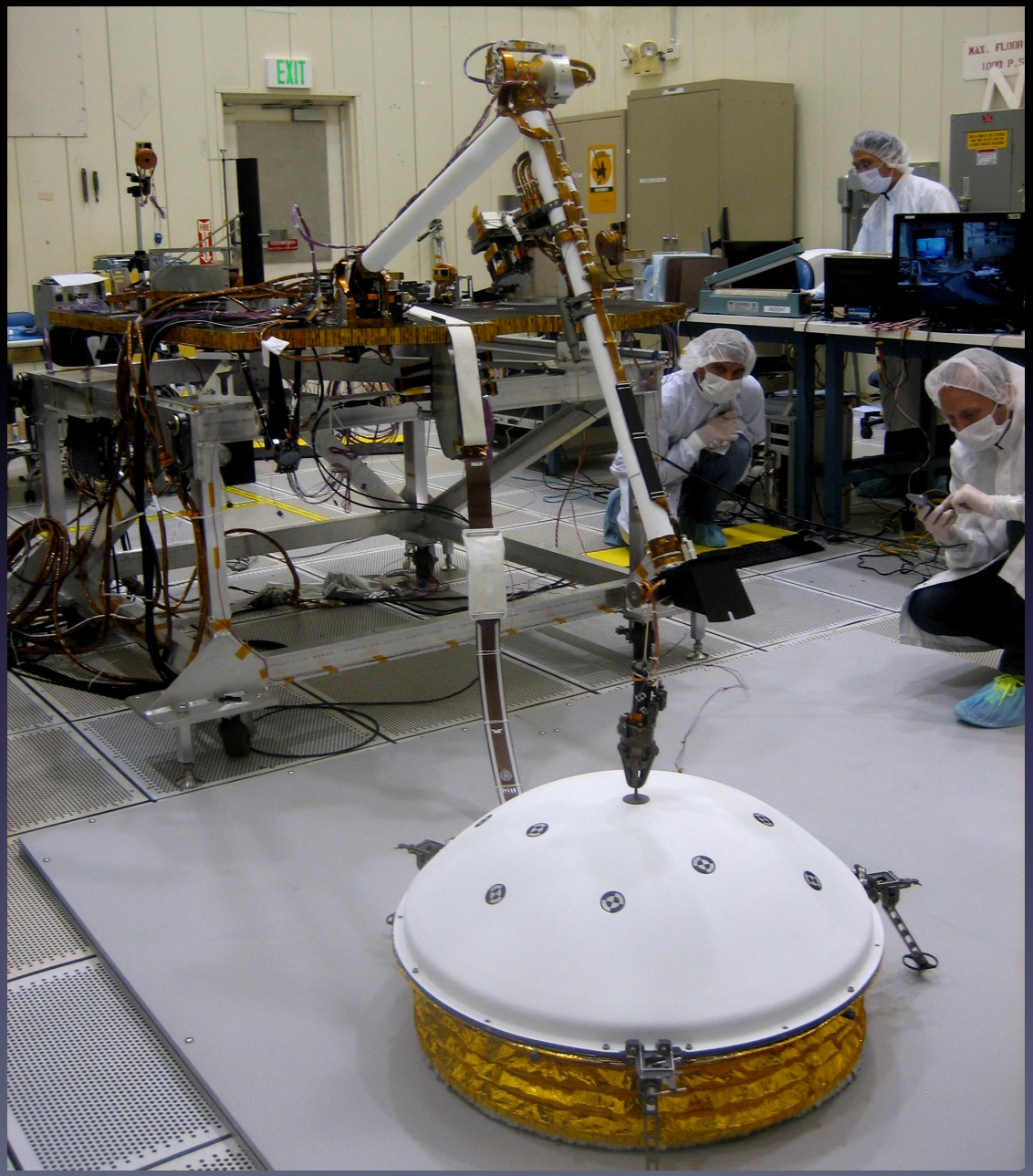
By tracking wobble, scientists can determine the distribution of the Red Planet's internal structures and better understand how the planet is built

The Arm

Will deploy the Seismic Experiment for Interior Structure instrument (SEIS)

Here the arm deployed a test model of a protective covering for SEIS, the instrument's wind and thermal shield

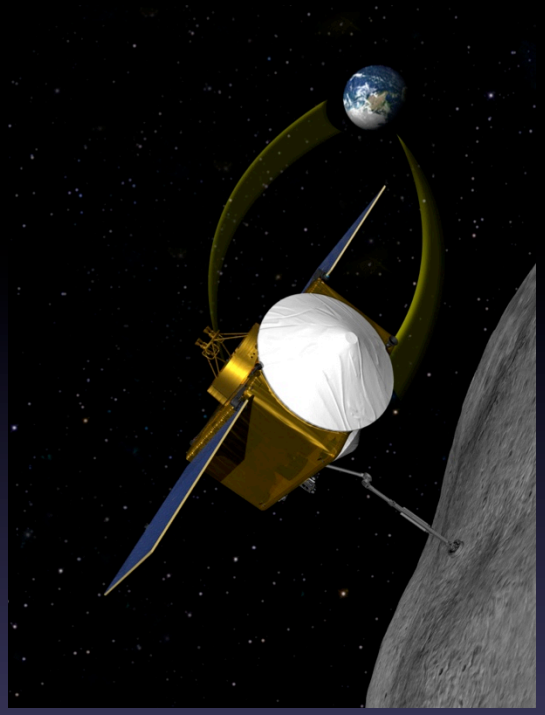
The shield lessens potential disturbances from weather to readings from the sensitive seismometer

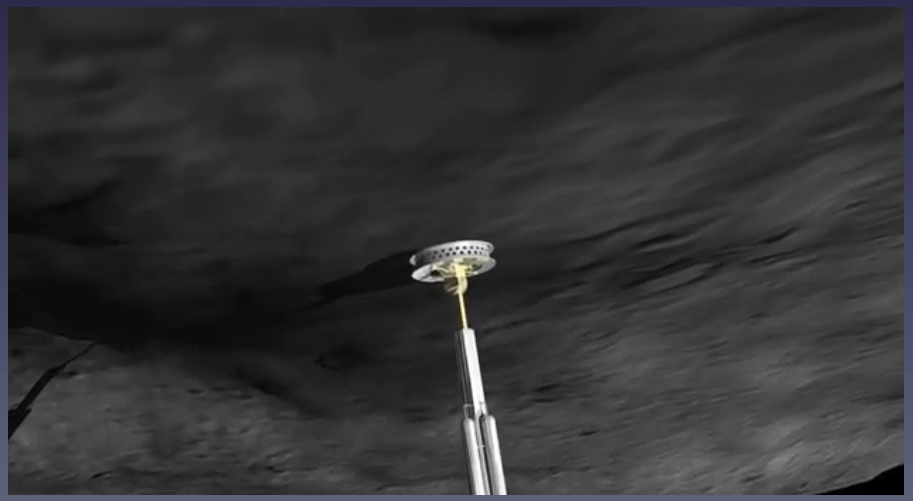


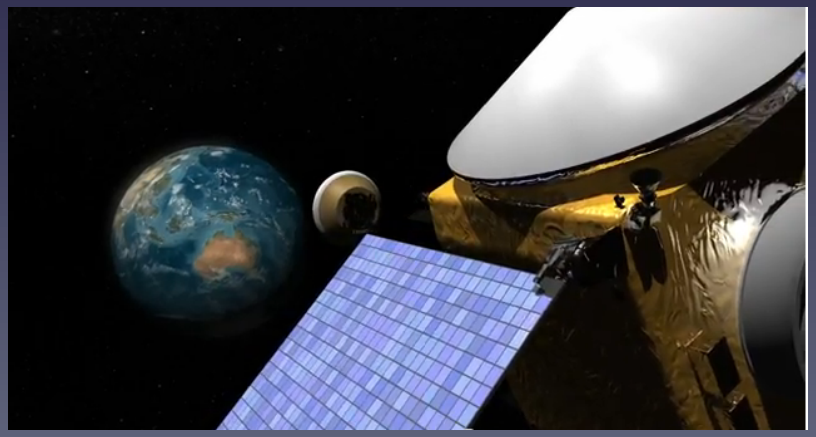
Returning Asteroid Dirt

OSIRIS-REx

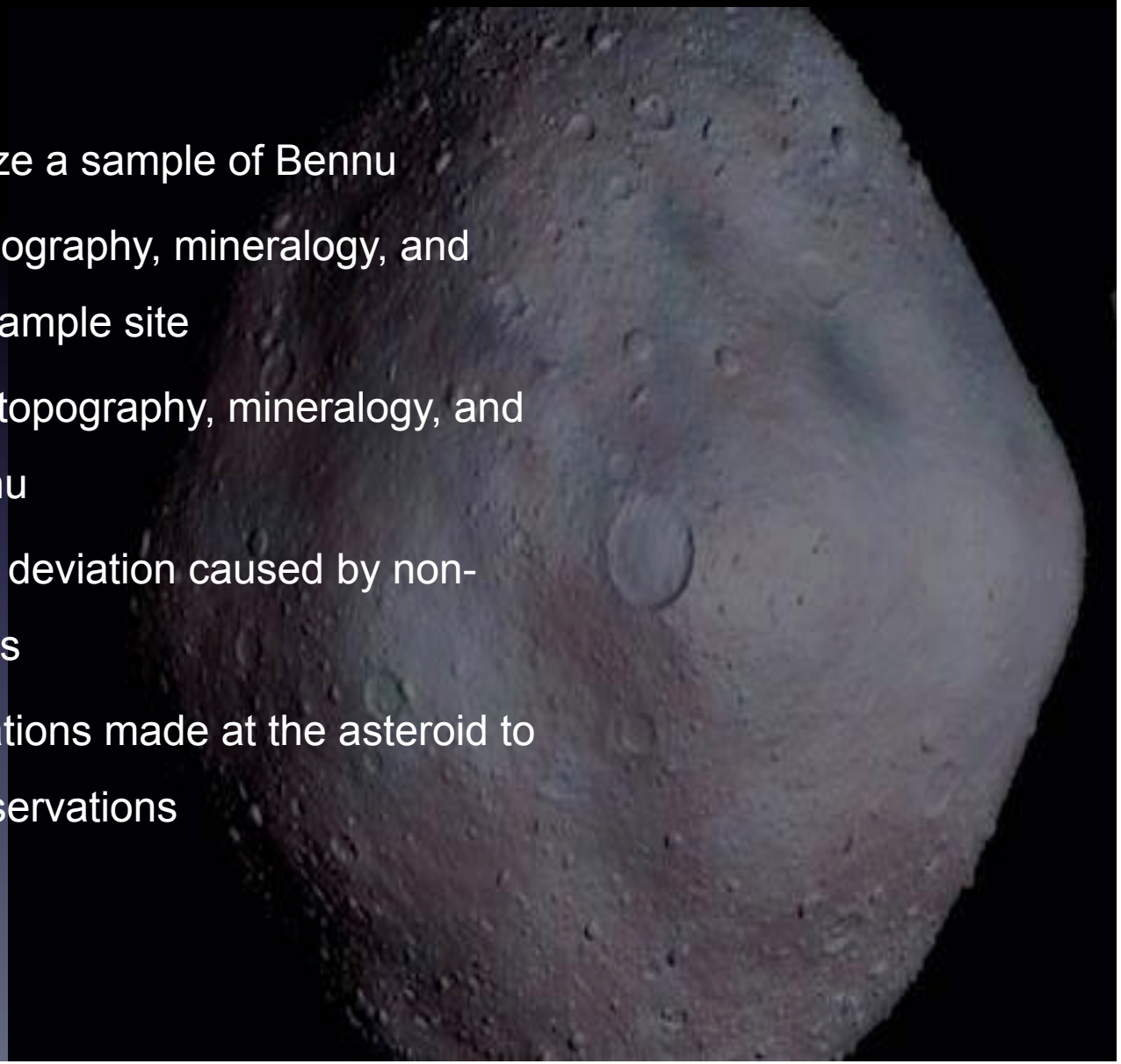
NASA's first asteroid sample return
- Sept. 2016 launch
- 2019 arrival at Asteroid Bennu to map, measure, then grab a soil sample
- 2023 return to Earth after a journey of 800 million miles







Science Objectives



- Return and analyze a sample of Bennu
- Document the topography, mineralogy, and chemistry of the sample site
- Globally map the topography, mineralogy, and chemistry of Bennu
- Measure the orbit deviation caused by non-gravitational forces
- Compare observations made at the asteroid to ground-based observations

Instruments

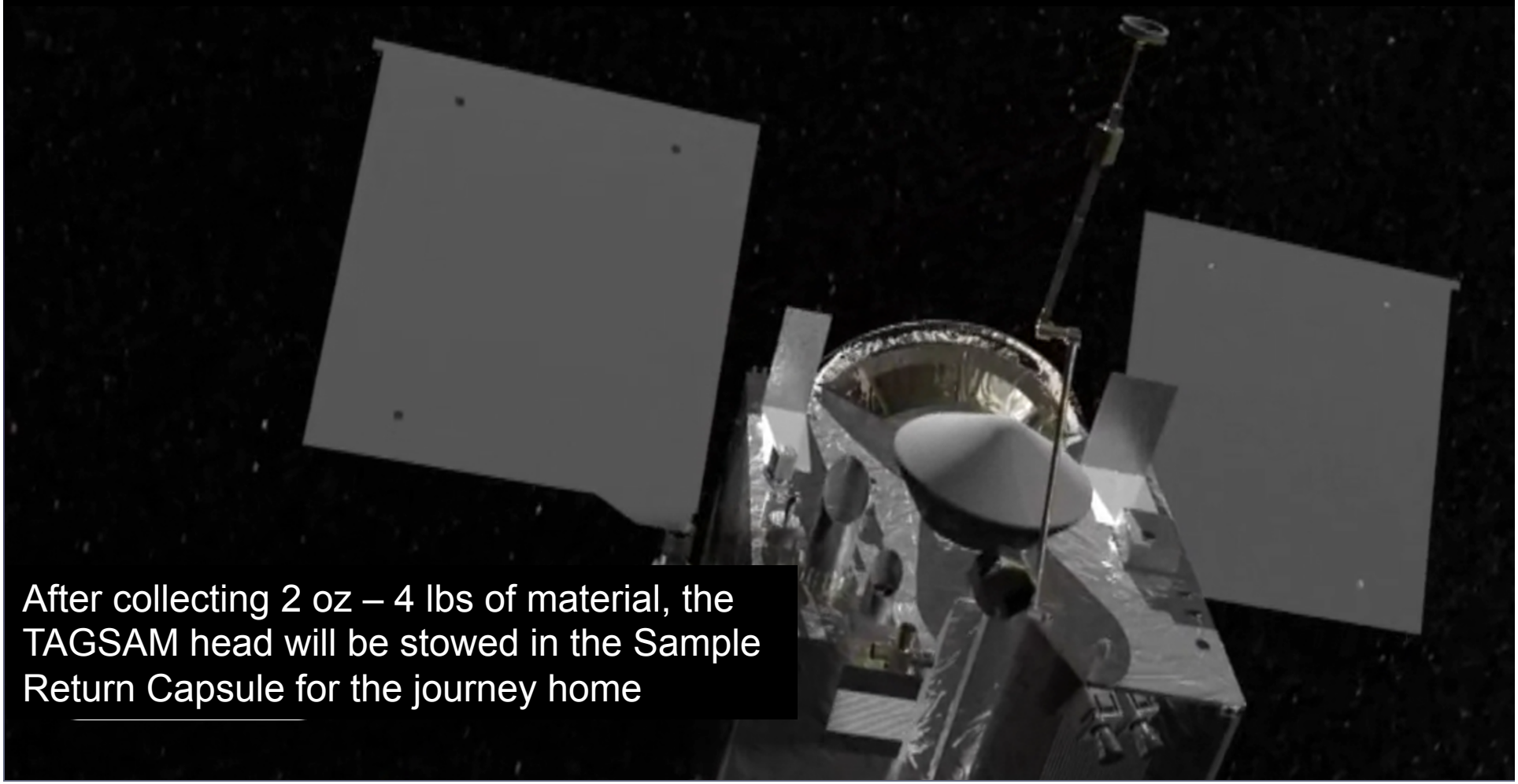
Laser Altimeter (OLA) will provide ranging data, global topographic mapping, and local topographic mapping of candidate sample sites

Regolith X-ray Imaging Spectrometer (REXIS) will perform global soft X-ray elemental abundance mapping, and sample site documentation

Visible and Infrared Spectrometer (OVIRS) will produce mineral and organic spectral maps, and local spectral information of candidate sample sites, in near-infrared

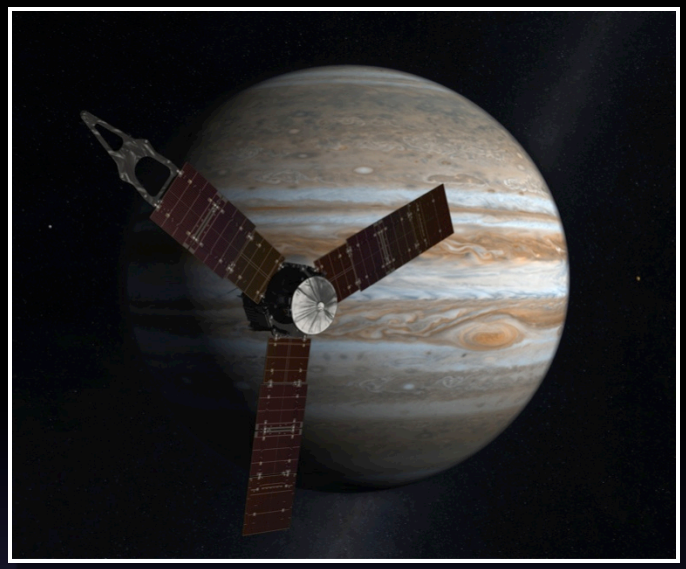
Thermal Emission Spectrometer (OTES) will produce mineral and thermal emission spectral maps, and local spectral information of candidate sample sites.

Touch-And-Go Sample Acquisition Mechanism (TAGSAM)



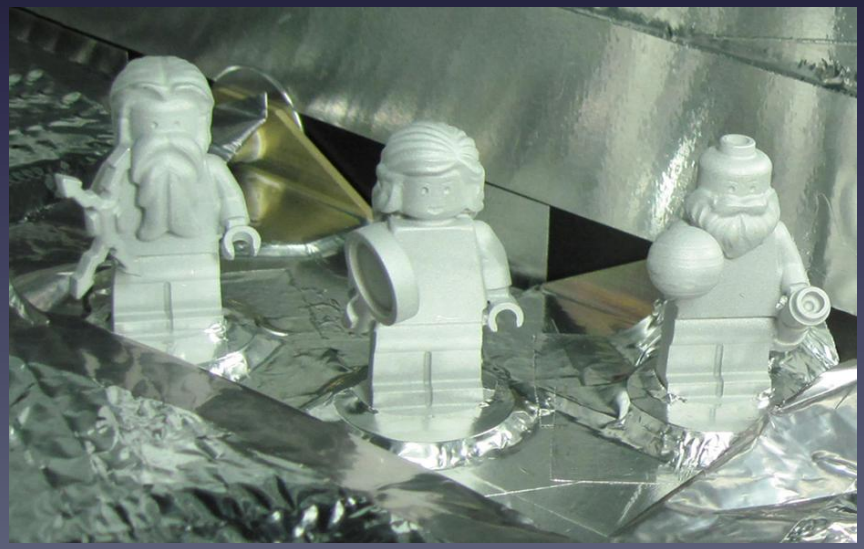
After collecting 2 oz – 4 lbs of material, the TAGSAM head will be stowed in the Sample Return Capsule for the journey home

Jupiter Orbiter

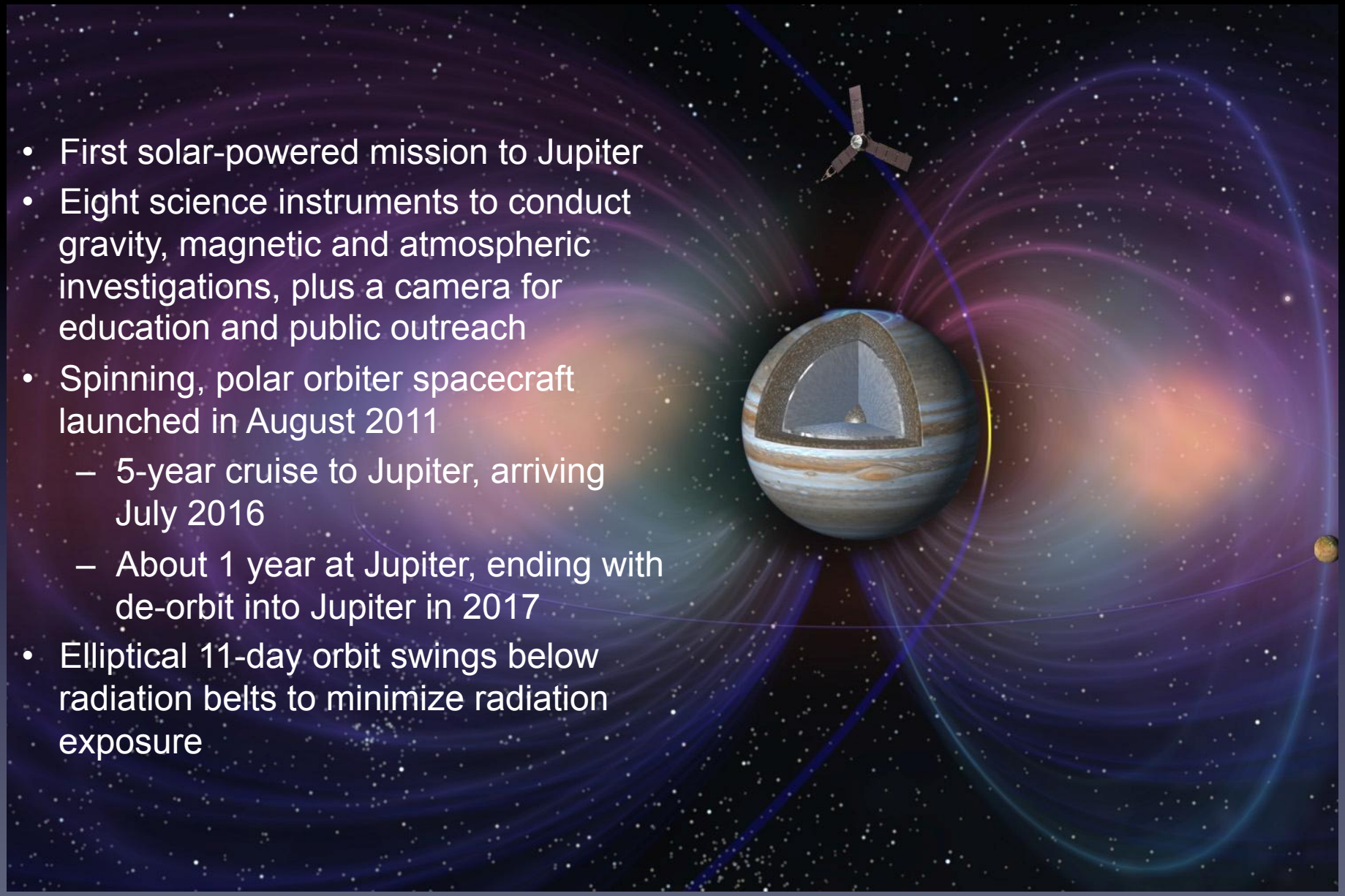


Juno

- How and where did Jupiter form?
- Juno will peer through the clouds to reveal hidden secrets from the formation and early evolution of the our solar system



Juno



- First solar-powered mission to Jupiter
- Eight science instruments to conduct gravity, magnetic and atmospheric investigations, plus a camera for education and public outreach
- Spinning, polar orbiter spacecraft launched in August 2011
  - 5-year cruise to Jupiter, arriving July 2016
  - About 1 year at Jupiter, ending with de-orbit into Jupiter in 2017
- Elliptical 11-day orbit swings below radiation belts to minimize radiation exposure

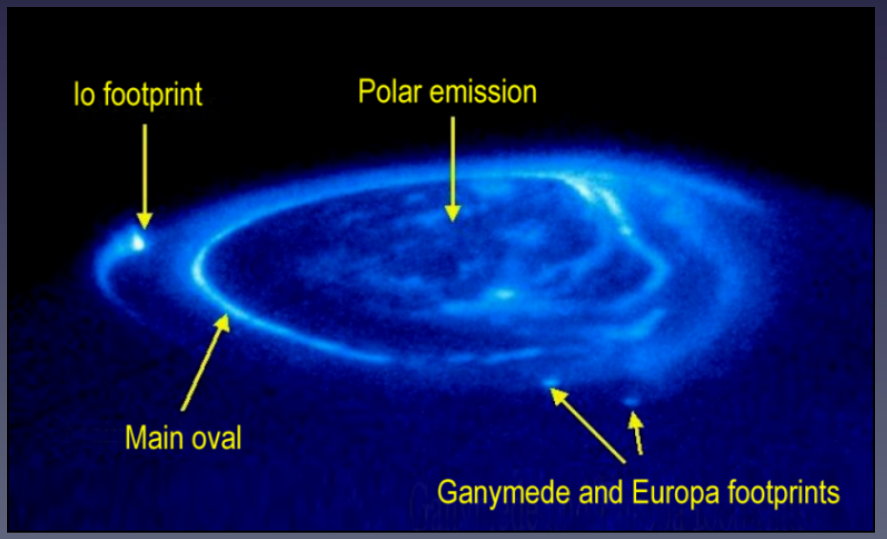
Juno Science Objectives

Origin
Determine the abundance of water and place an upper limit on the mass of Jupiter's dense core to decide which theory of the planet's origin is correct

Interior
Understand Jupiter's interior structure and how material moves deep within the planet by mapping its gravitational and magnetic fields

Atmosphere
Map variations in atmospheric composition, temperature, cloud opacity and dynamics to depths greater than 100 bars at all latitudes

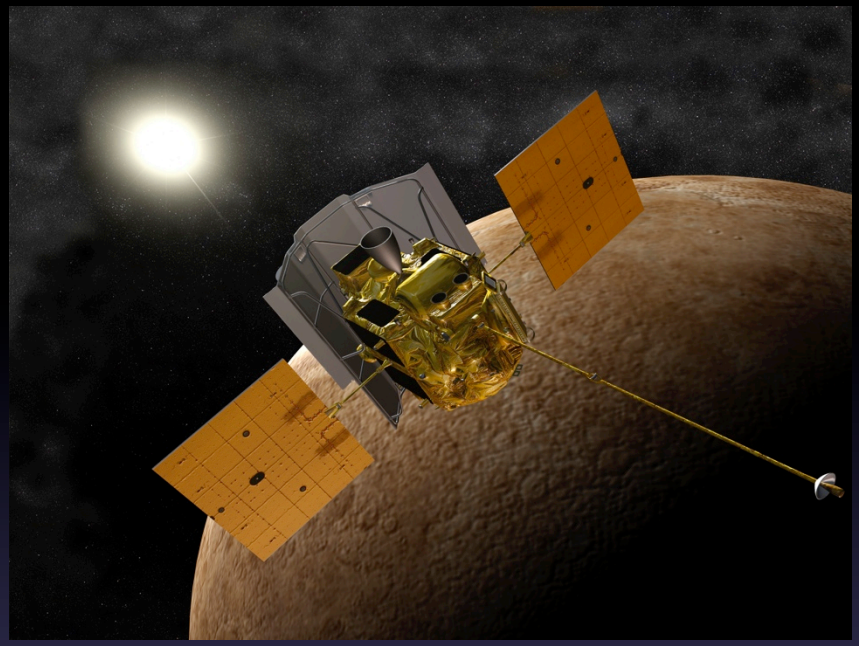
Magnetosphere
Characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras.

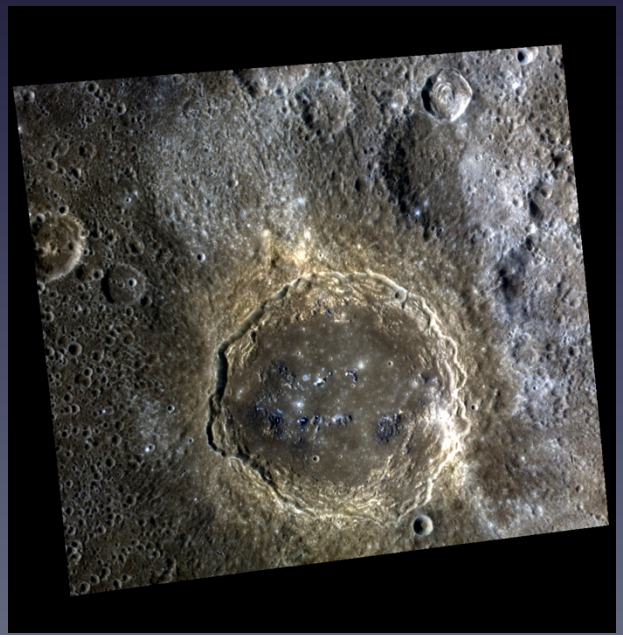


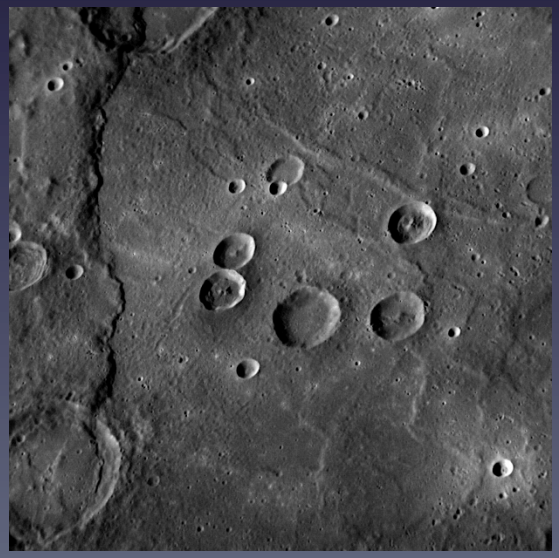
Mercury Revealed!

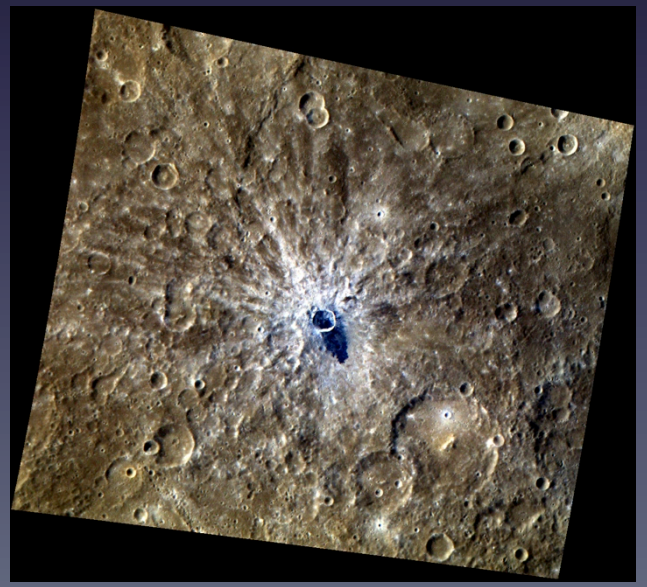
MESSENGER

First spacecraft to orbit the planet closest to the Sun, beginning in March 2011. Continues to return fantastic close-up images that are generating new questions

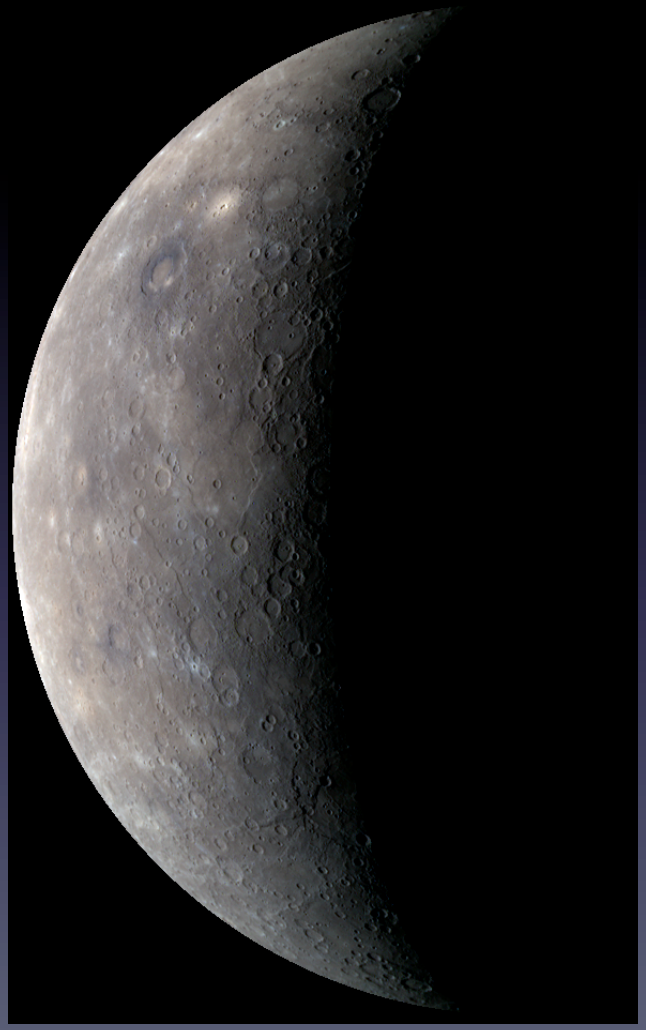






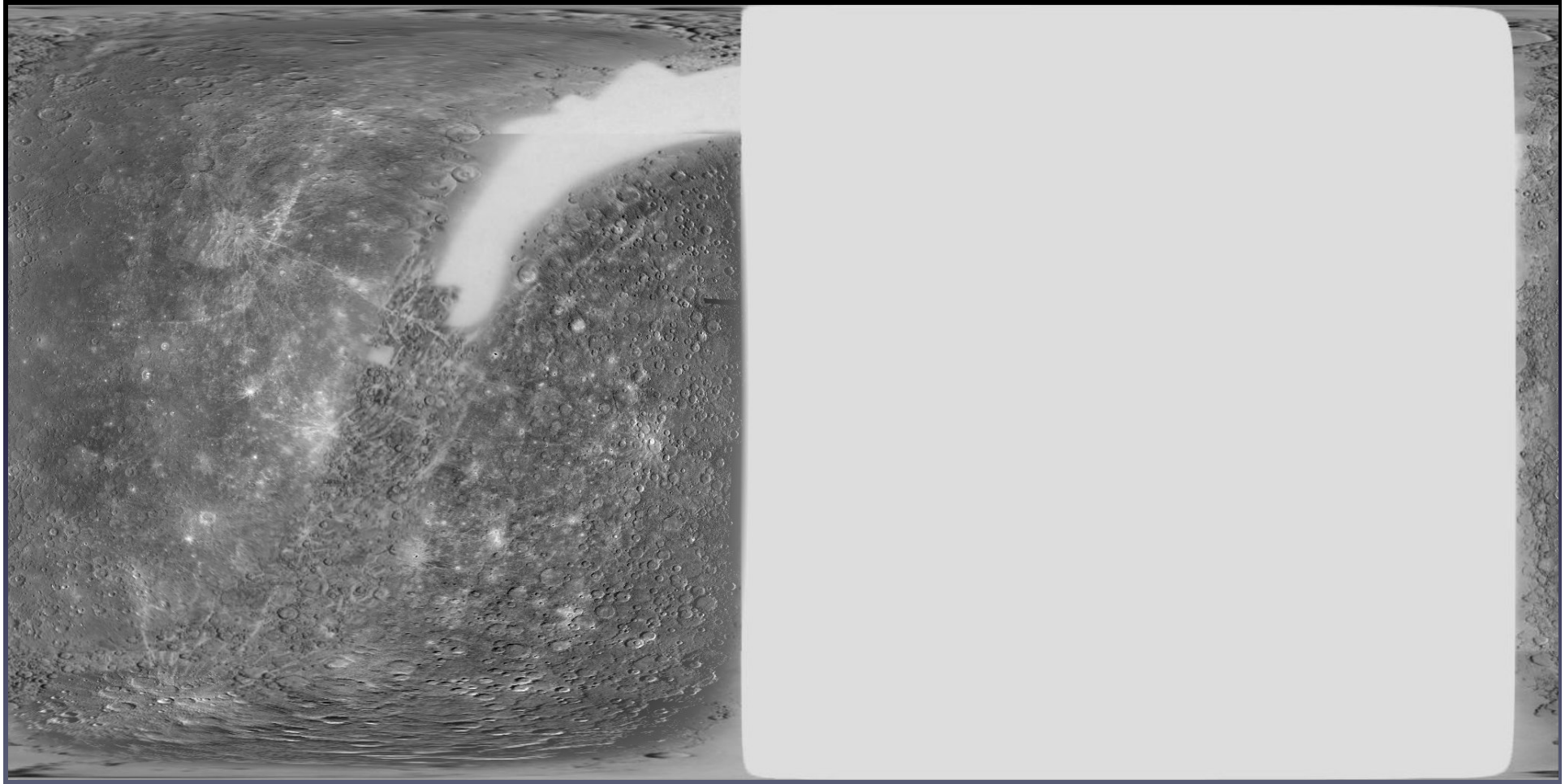


Science Questions

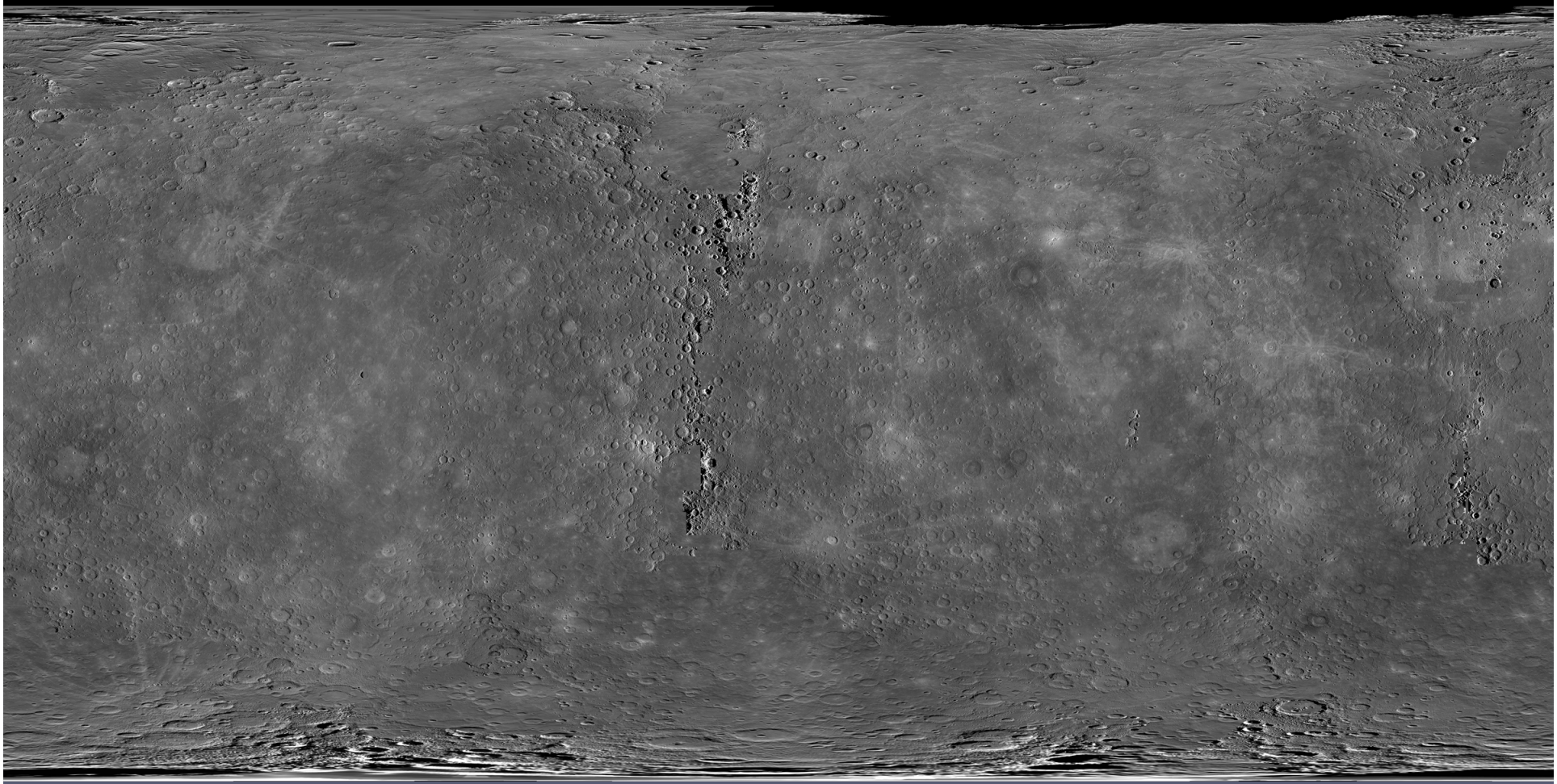


- How did Mercury form?
- How did Mercury evolve geologically?
- What can we learn about planetary magnetic fields from Mercury?
- How is the interior organized?
- What are the radar bright features at the poles?
- How and why do materials that easily volatilize to a gas move around Mercury's surface and atmosphere?

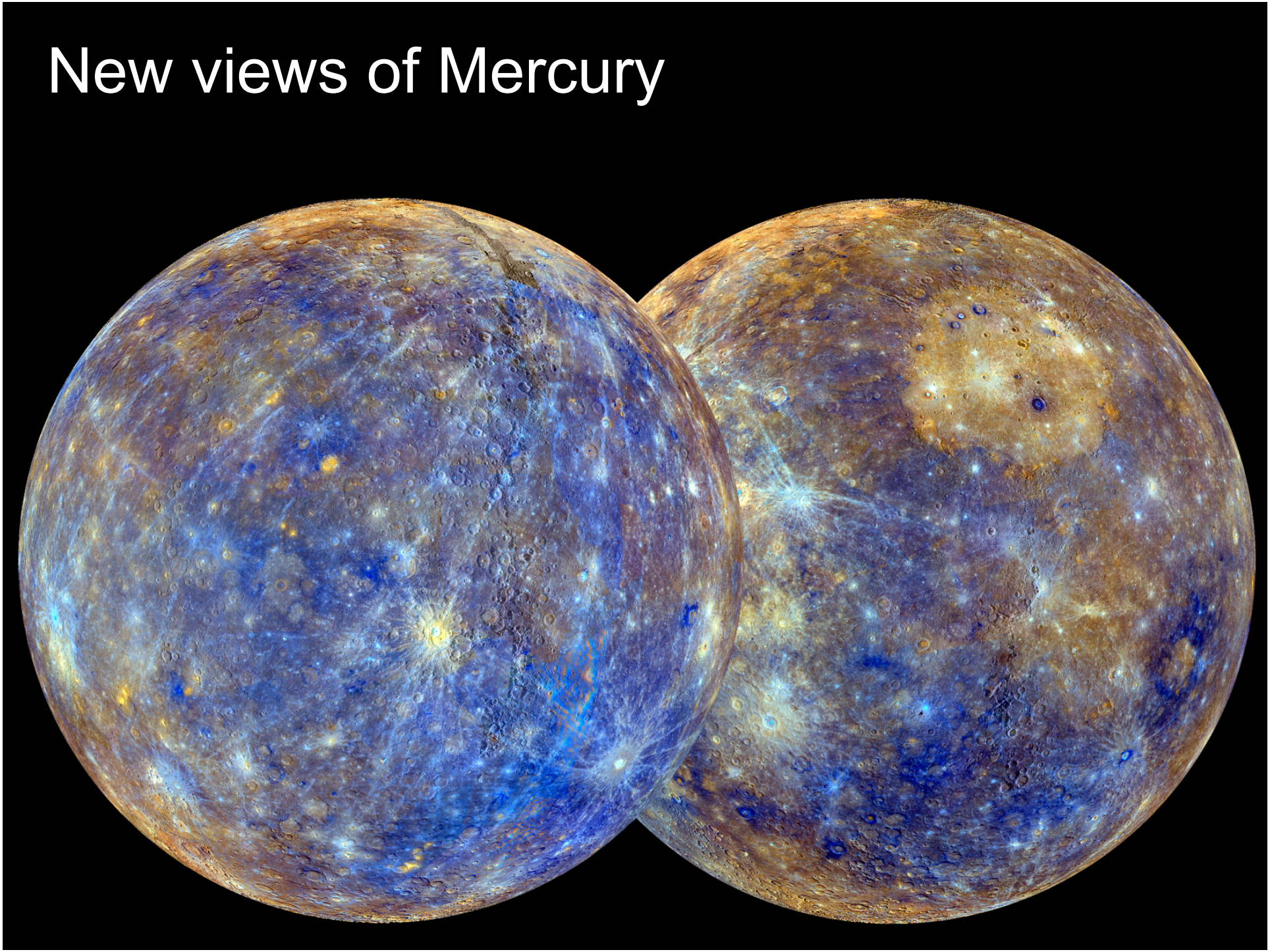
Before MESSENGER



After MESSENGER

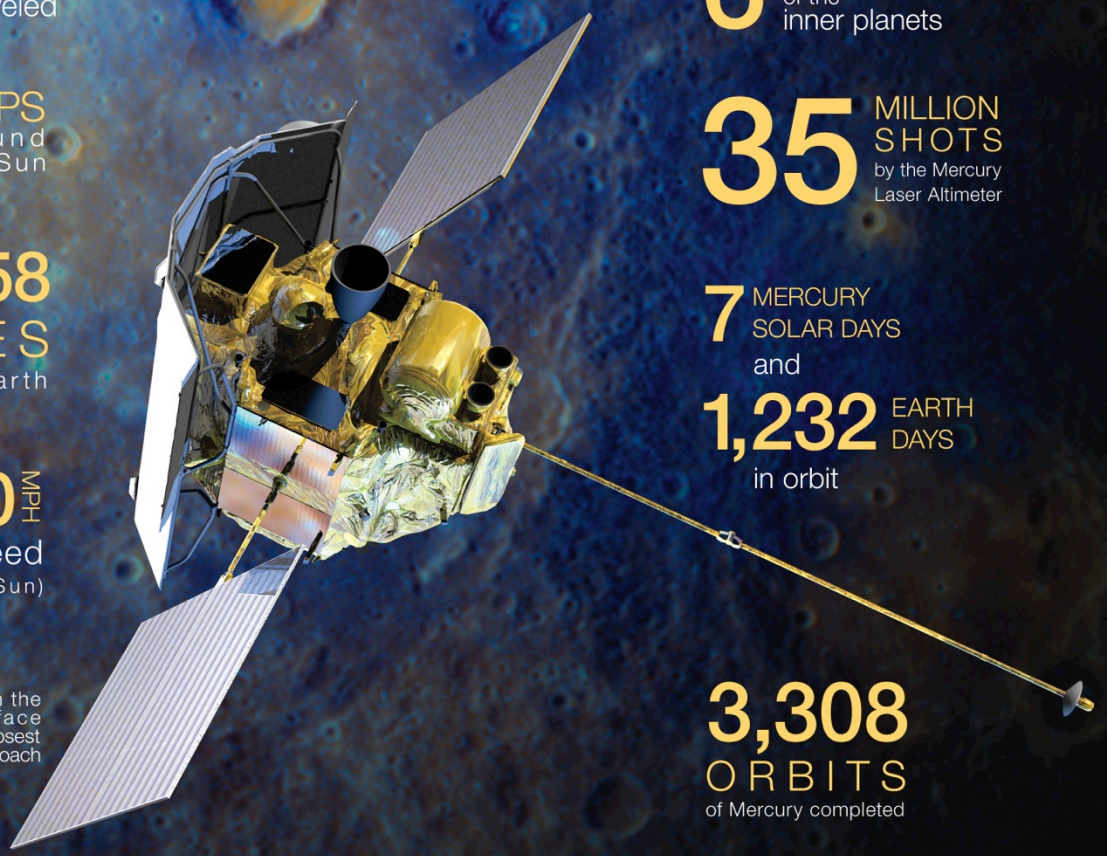


New views of Mercury



MESSENGER: 10 Years in Space

BY THE NUMBERS*



8 BILLION miles traveled

29 TRIPS around the Sun

255,858 IMAGES returned to Earth

91,730 MPH average speed (relative to the Sun)

60 MILES from the surface at closest approach

10 TERABYTES of science data publicly released

6 FLYBYS of the inner planets

35 MILLION SHOTS by the Mercury Laser Altimeter

7 MERCURY SOLAR DAYS and **1,232 EARTH DAYS** in orbit

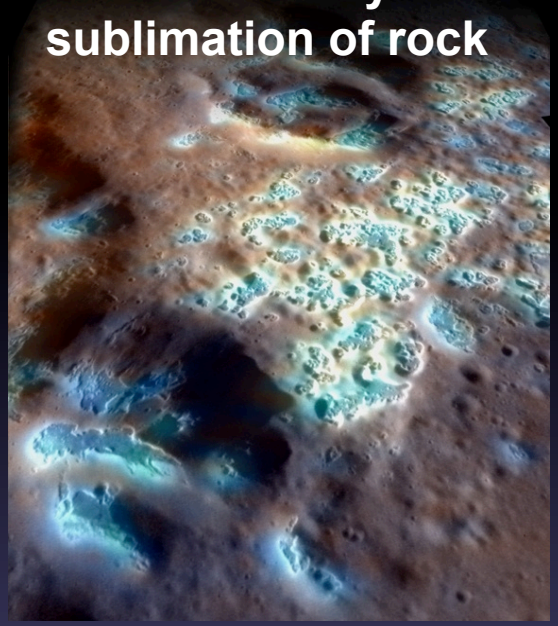
3,308 ORBITS of Mercury completed

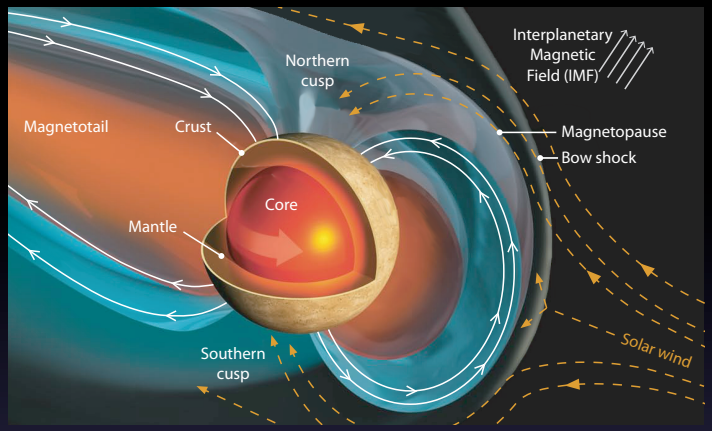
*As of August 1, 2014

1ST3_14-02371

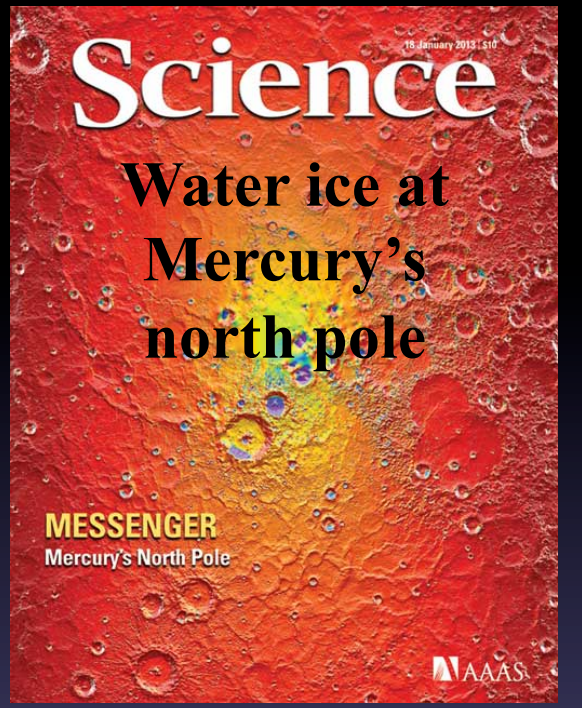
Key Findings and Achievements

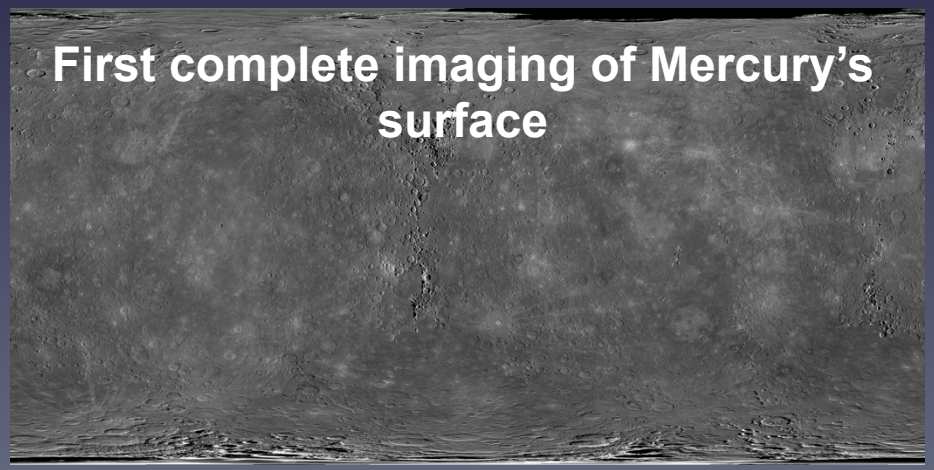
Erosion by sublimation of rock

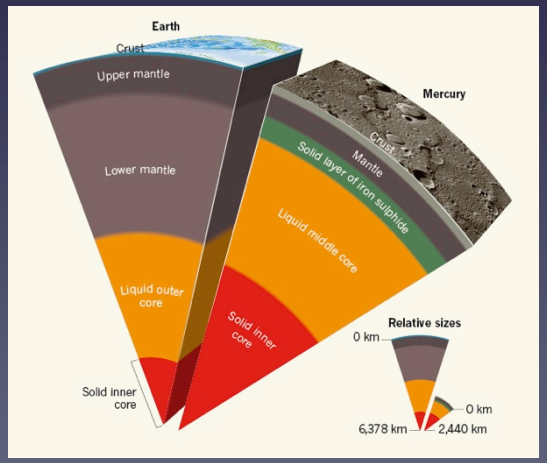




Mercury's offset magnetic field



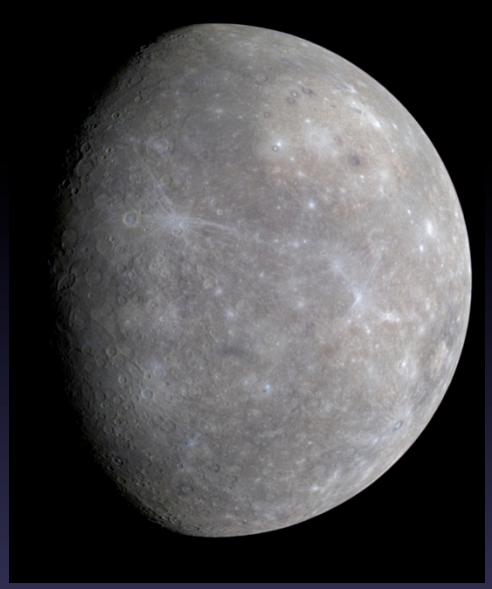


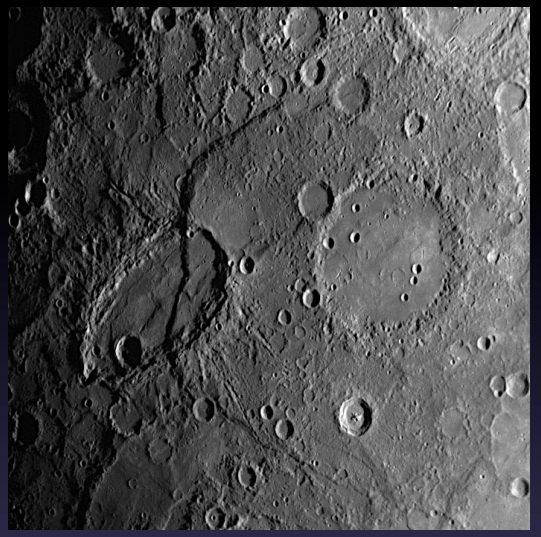


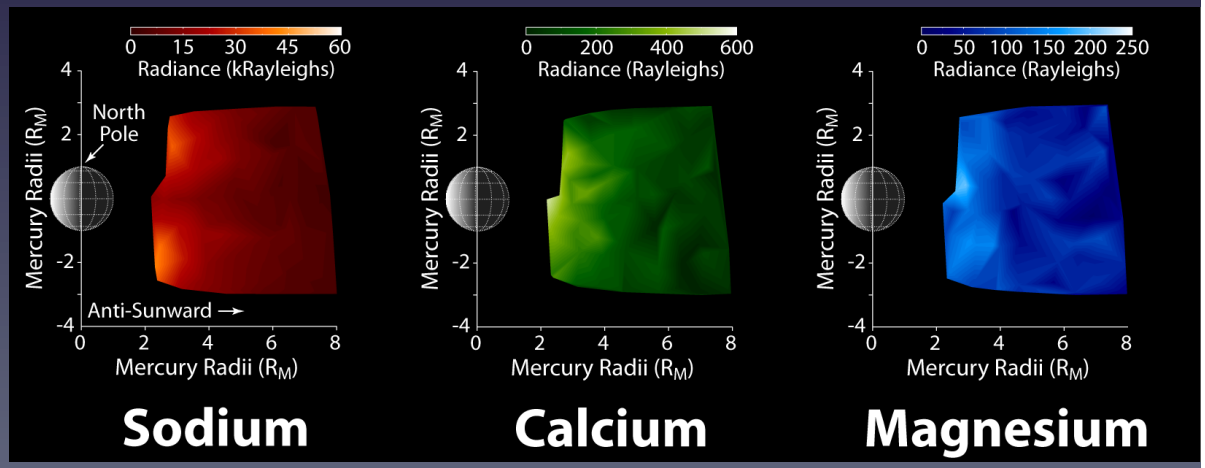
Mercury's internal layers

MESSENGER's continuing mission…

- Map the surface
  - Geology
  - Composition
  - Topography
  - Gravity
  - Polar deposits
- Characterize the environment
  - Atmosphere
  - Magnetic field
  - Solar-wind interaction







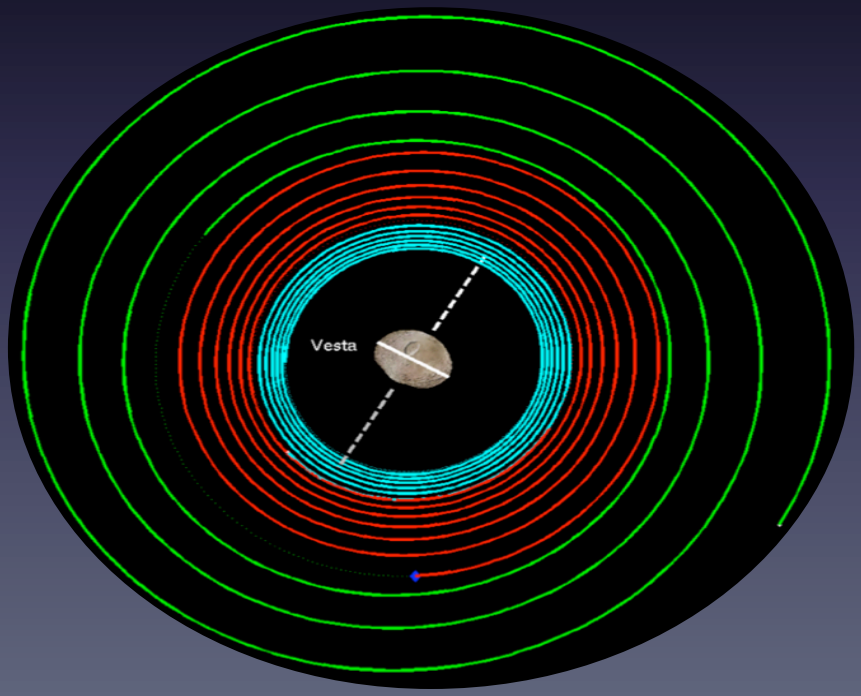
Comparing Asteroids

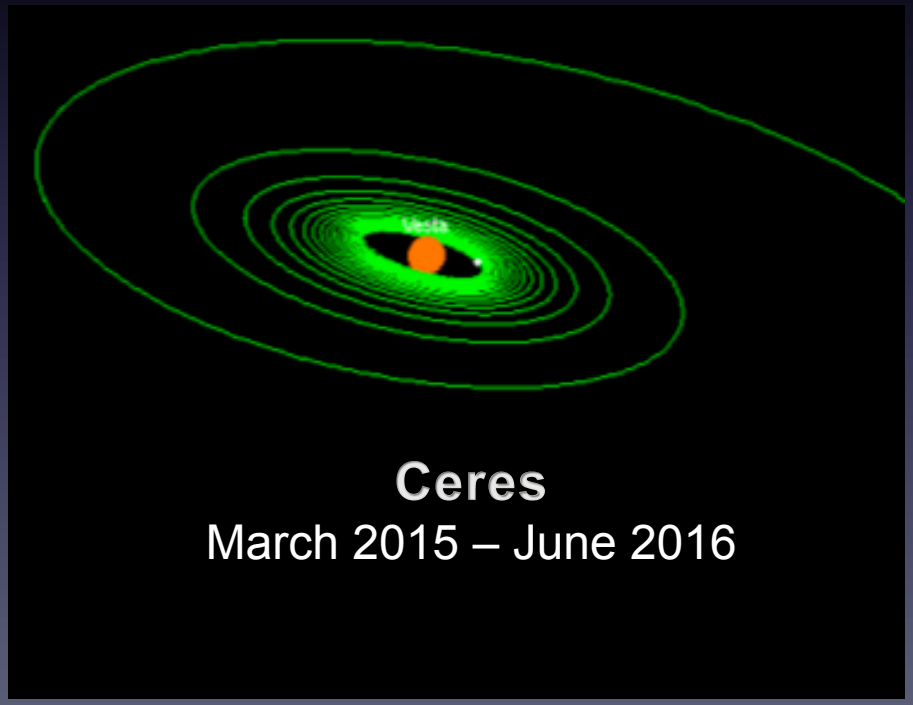
Dawn

Orbited Vesta for 12 months, now circling Ceres for a close-up comparison of these two very large and very different asteroid belt objects

Dawn is the first mission to orbit and explore *any* two extraterrestrial destinations

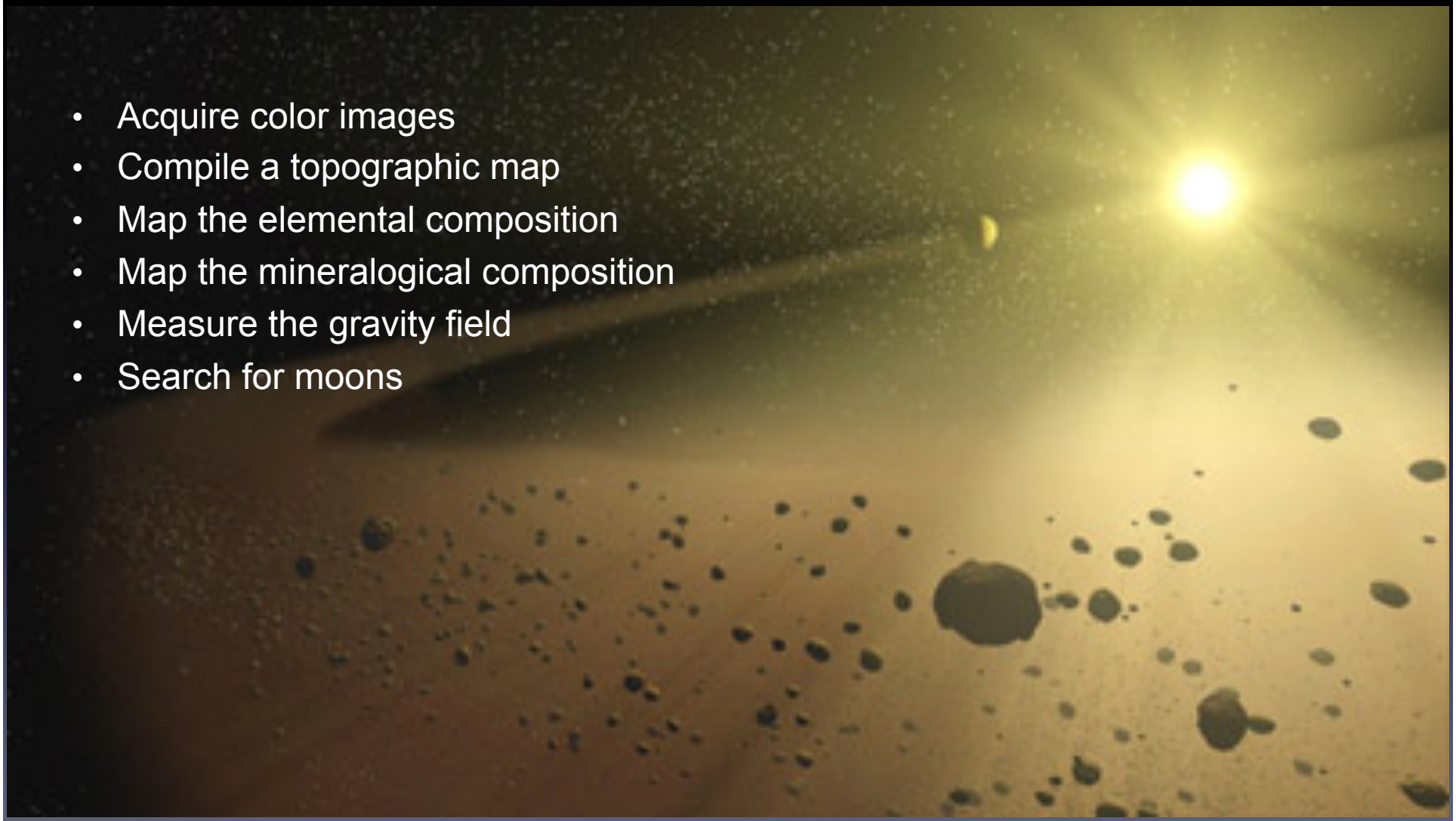
Vesta
July 2011 – September 2012





Ceres
March 2015 – June 2016

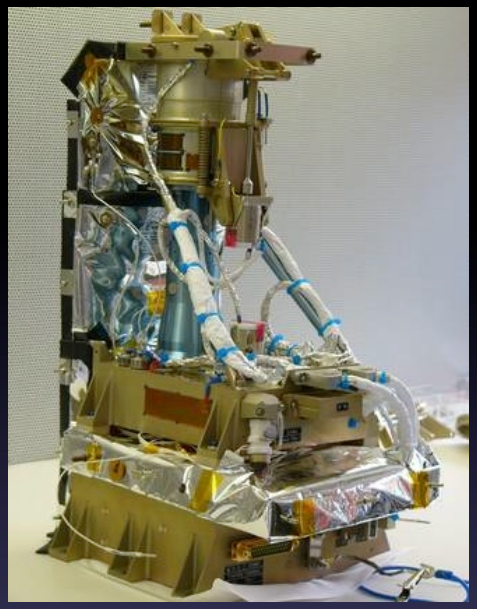
Science Objectives



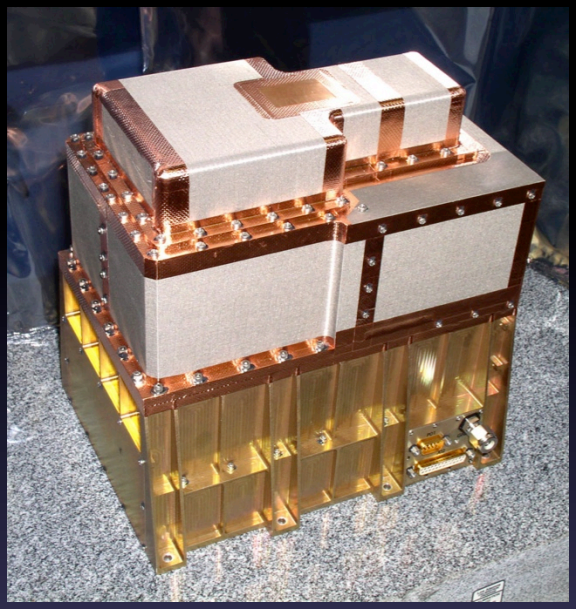
- Acquire color images
- Compile a topographic map
- Map the elemental composition
- Map the mineralogical composition
- Measure the gravity field
- Search for moons

Dawn Uses Ion Propulsion

Dawn Instruments



Framing Camera



Gamma Ray and Neutron Detector

Visible and Infrared Mapping Spectrometer

Impacts Sent Pieces of Vesta to Earth

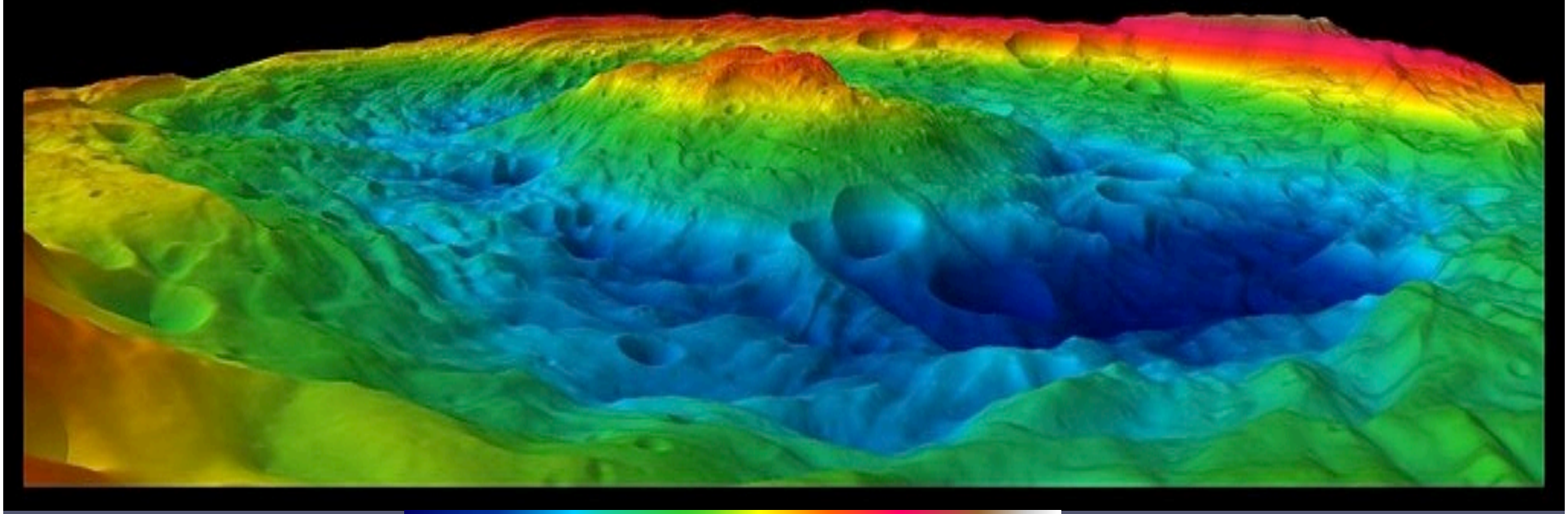
More Meteorites from Vesta than from the Moon and Mars Combined

Remnants of the Impacts

The massive impacts rippled through Vesta, leaving giant scars across the surface

Largest Mountain

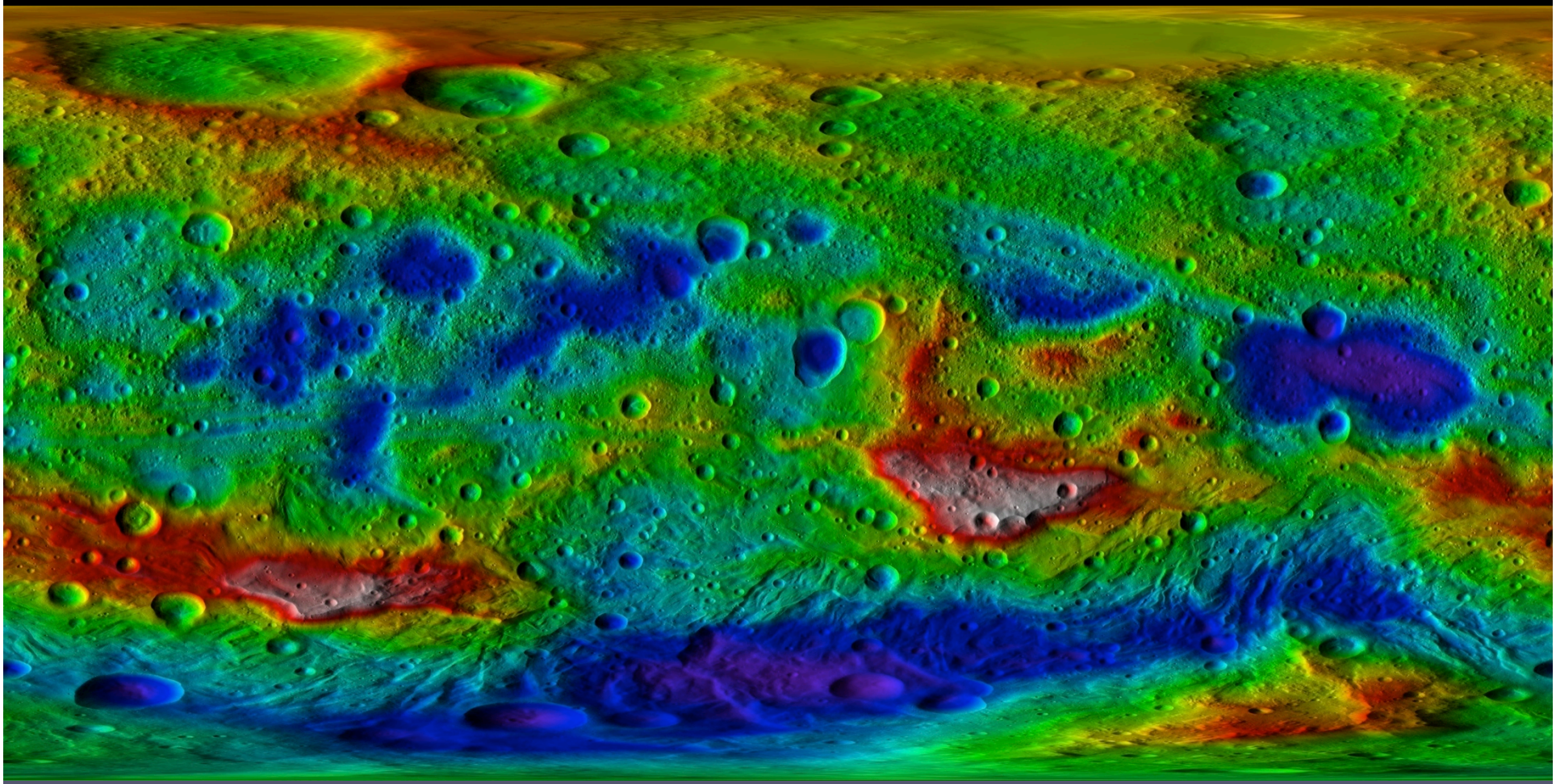
Rheasilvia's central peak is more than twice as high as Mt. Everest – rivaling Olympus Mons (on Mars) as the tallest mountain in the solar system



-14 miles

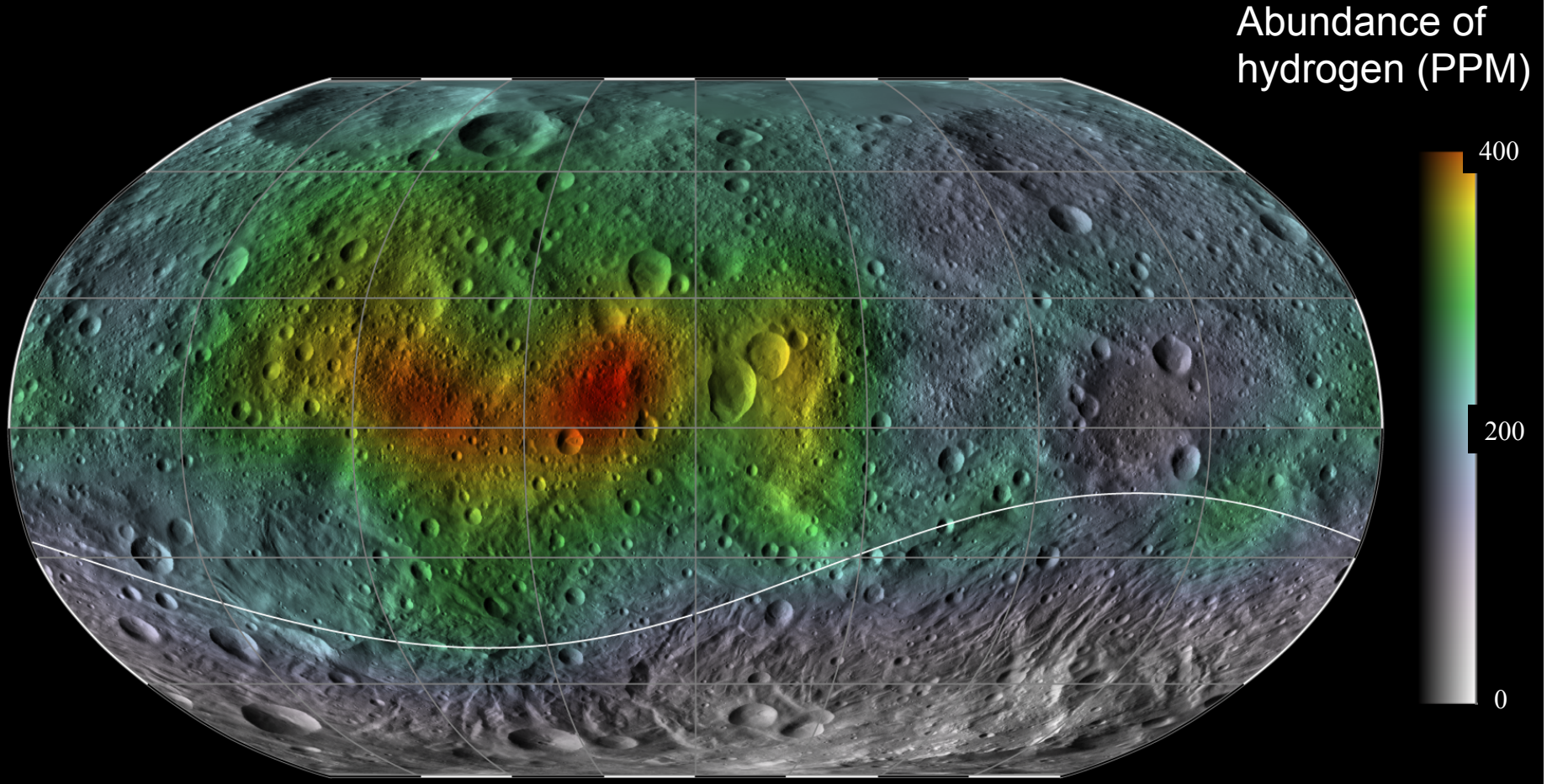
+12 miles

Vesta's Rugged Topography



The Snowman

Hydrogen on Vesta

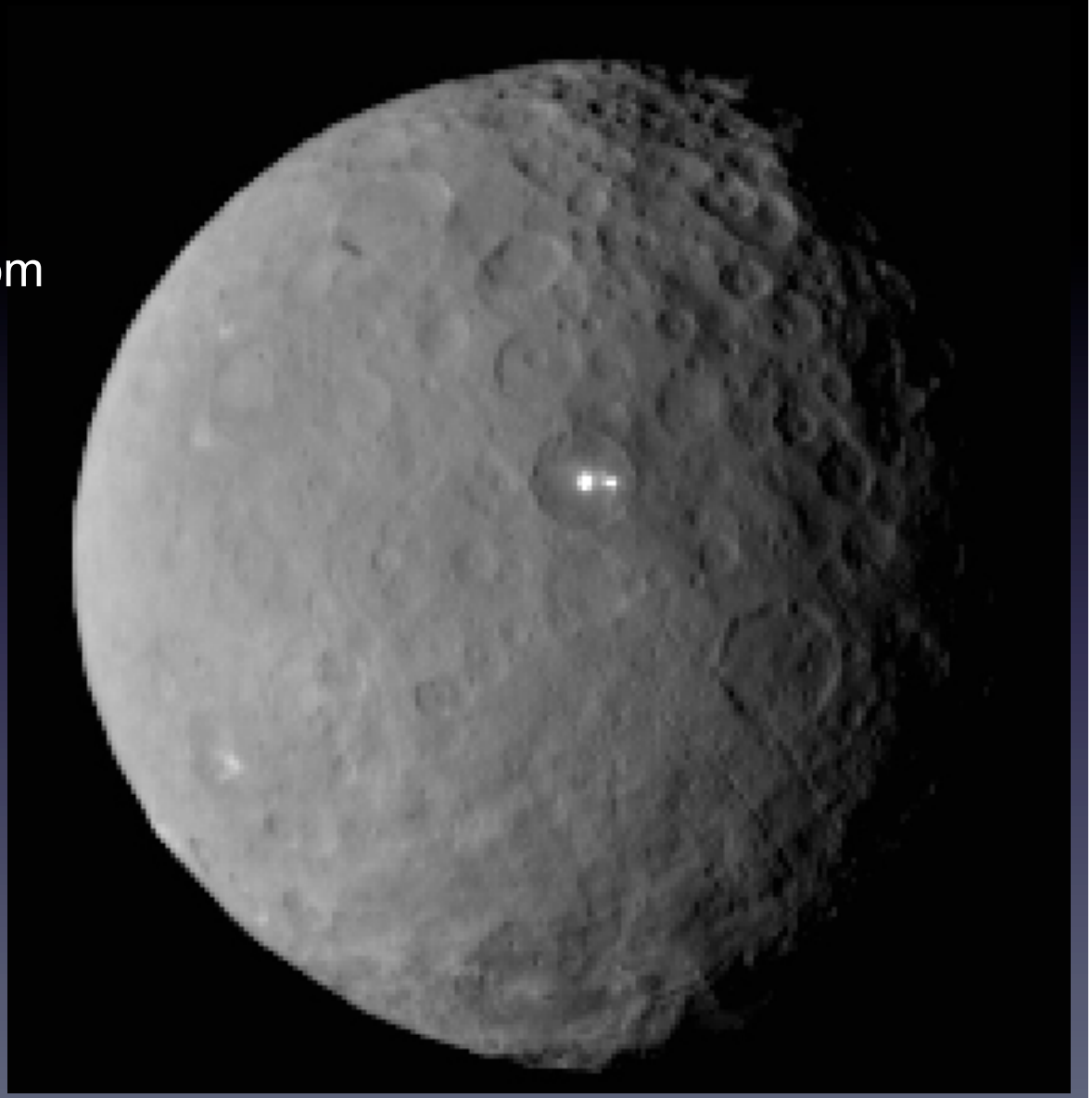


Dawn discovered significant amounts of hydrogen on Vesta's surface that appears to have come from impactors

Dawn is the First Mission to Reach a Dwarf Planet

Mysteries on Ceres

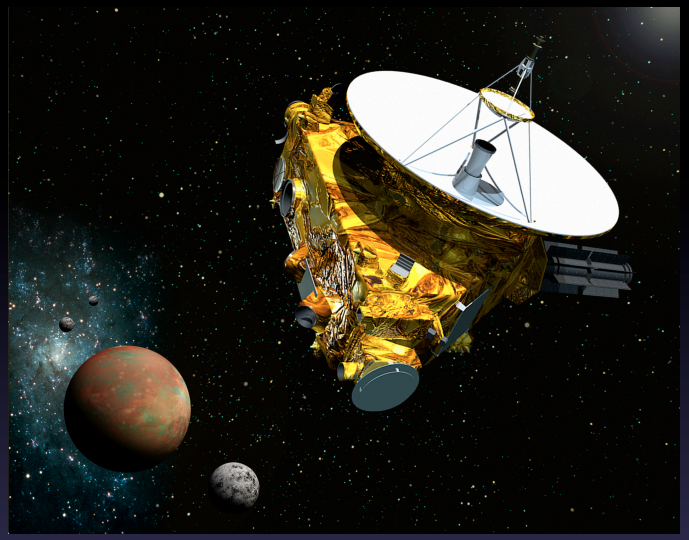
- Bright spots revealed from 29,000 miles away
- Volcanic origin?
- Stay tuned!

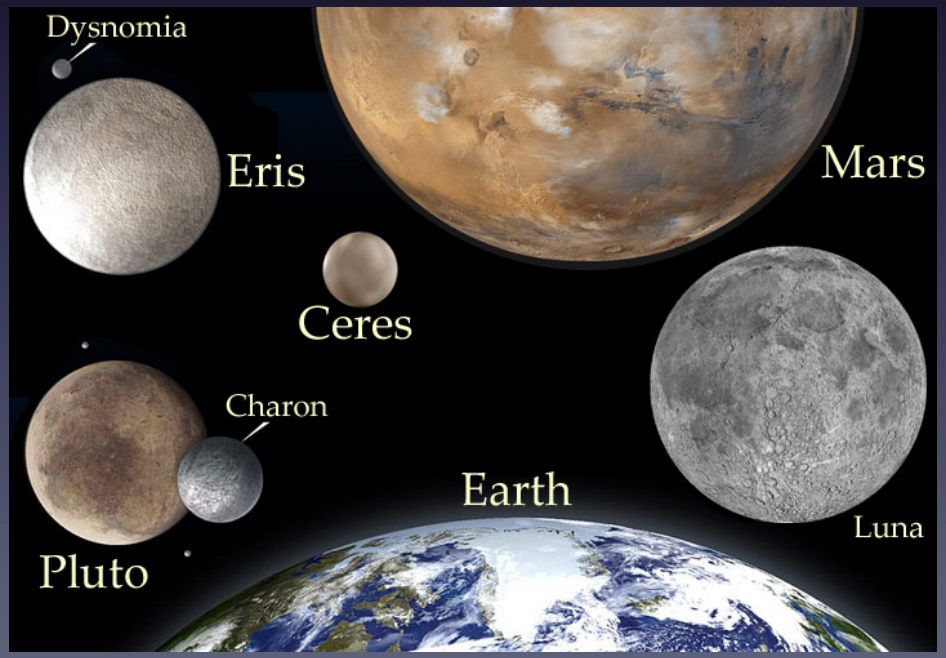


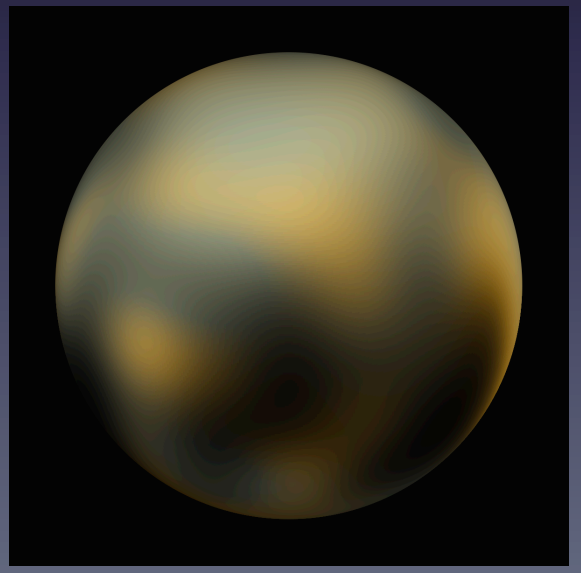
Pluto – Four Months from Flyby!

New Horizons

First mission to study Pluto, its moons and Kuiper Belt objects, to reveal how ice dwarf planets formed and have evolved over time and where they fit in with other solar system objects



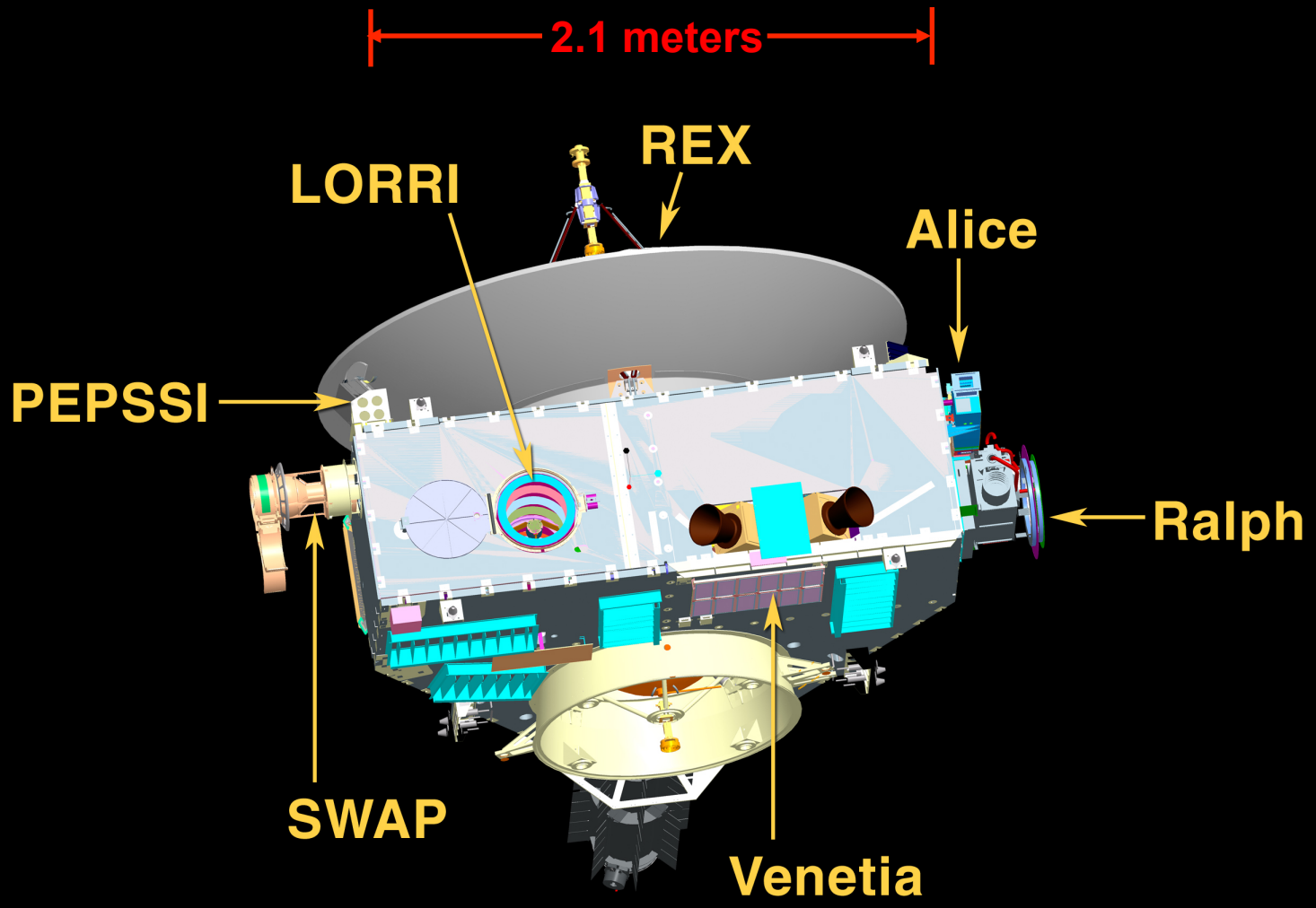




ience Questions

- What is the atmosphere made of, and how does it behave?
- What does the surface of Pluto look like?
- Are there big geological structures?
- How does the solar wind interact with Pluto's atmosphere?

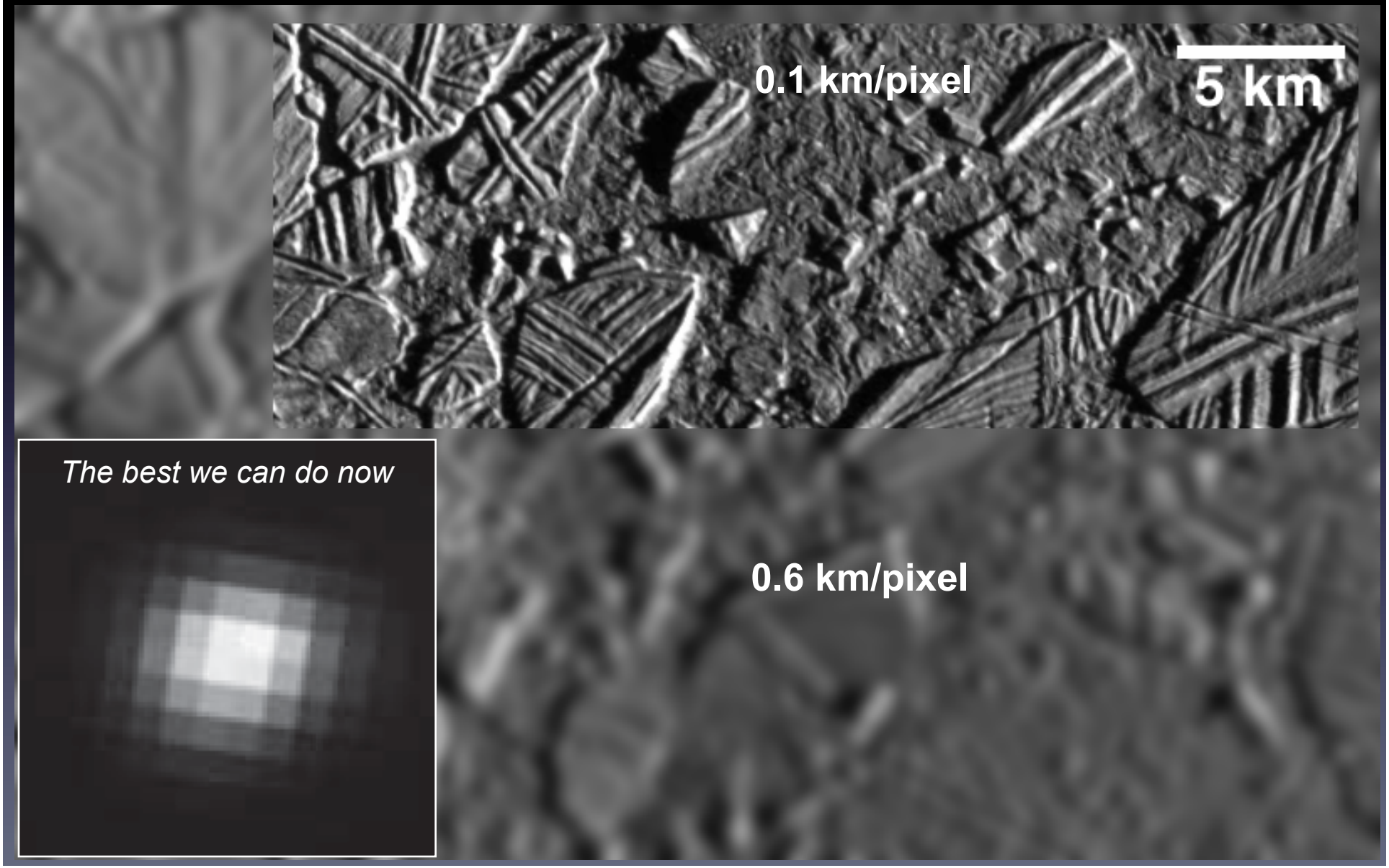
Spacecraft and Instruments



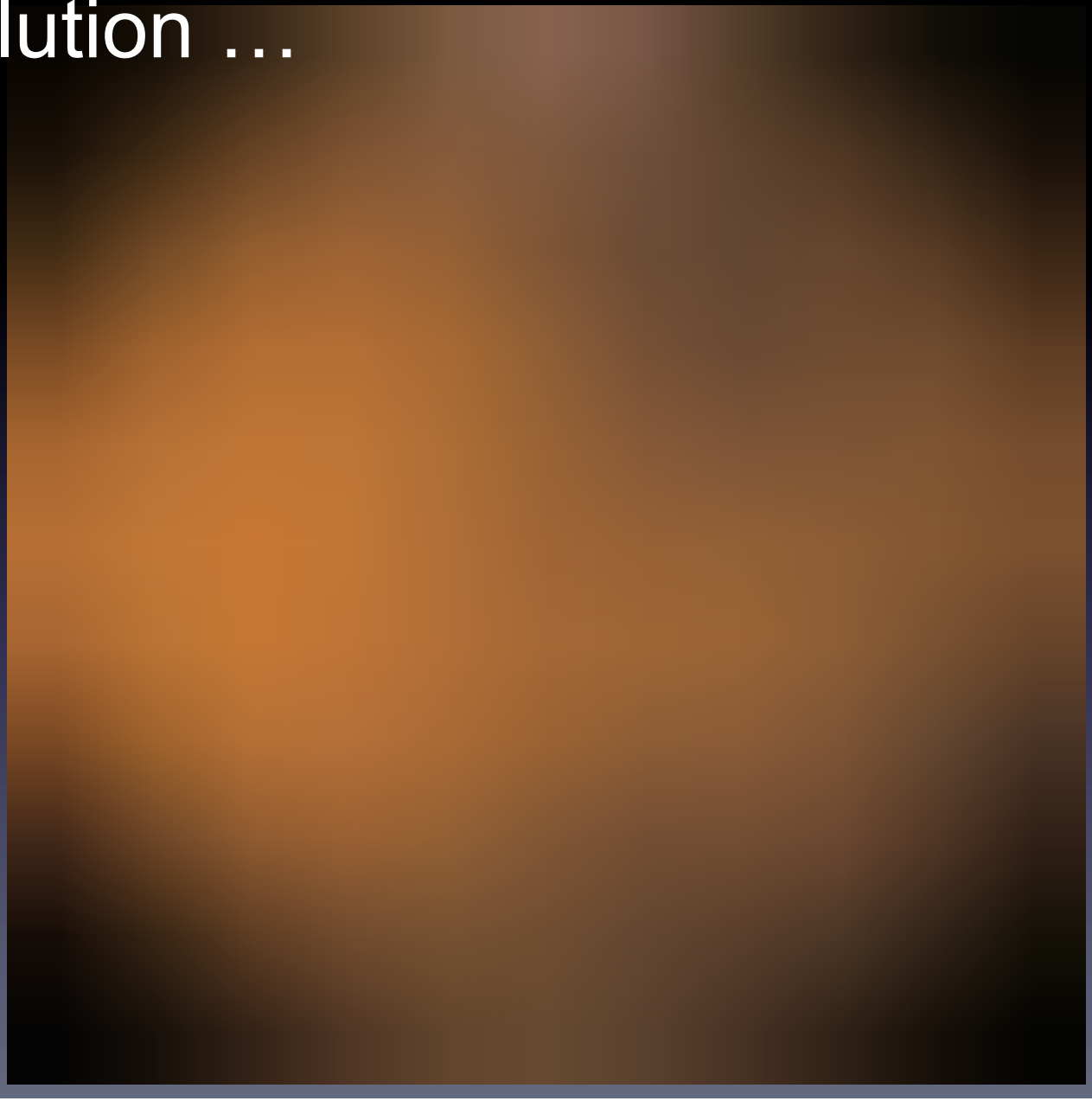
What Do We Know about Pluto?

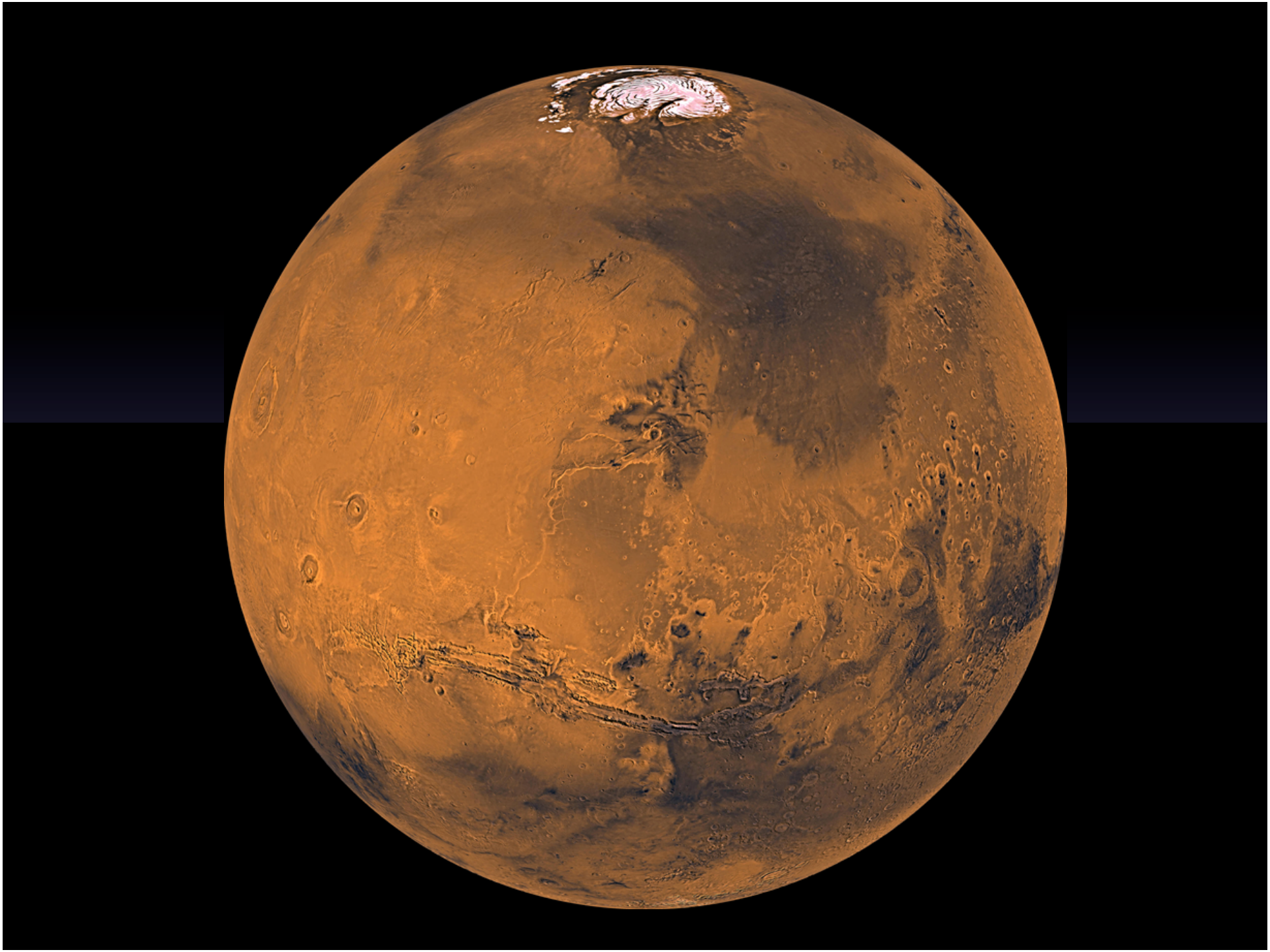
- Orbit: highly elliptical, highly inclined, *248 years to orbit the Sun*
- Rotational period: 6.4 days
- Small (diameter: 1,455 miles)
- Rock/ice object with bright surface frosts – an icy dwarf
- Highly variegated surface (bright and dark regions)
- Reddish in color, probably due to surface organics
- Tenuous, variable atmosphere
- In a region of the solar system we didn't even know existed until the 1990s

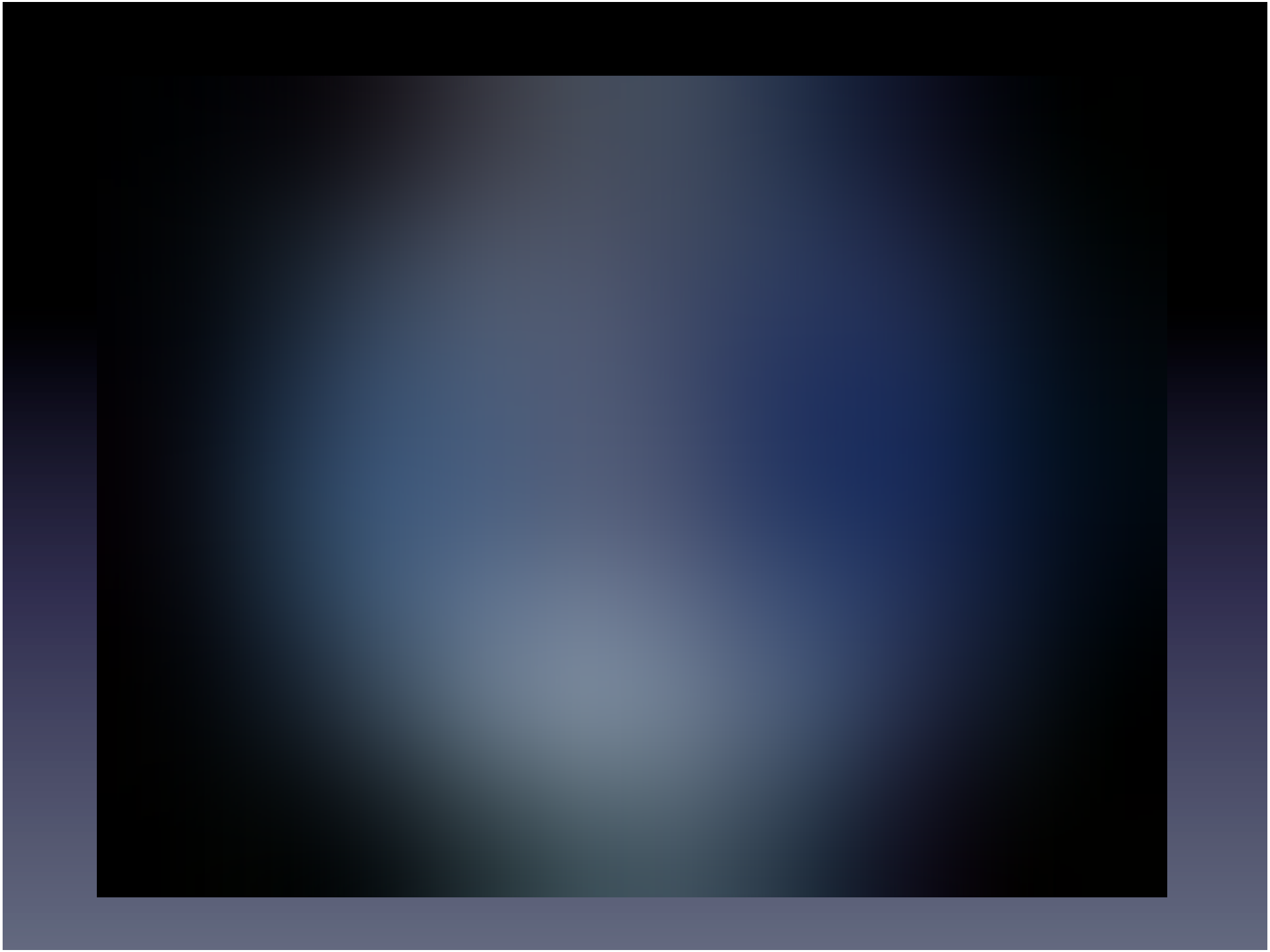
New Horizons Resolution on Pluto



Examples in Today's 'Pluto-Type' Resolution …







Expect Dramatic Results!

Opportunities to Participate

Each mission requires hundreds of people to formulate the sciences questions, build the machines, design the flight path, develop the software, program the computers, create graphics and animations, tell the story and get the mission launched into space!

Learn More

Find out much more about all these missions that are visiting **New Worlds** and making **New Discoveries**

discovery.nasa.gov

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YOUR STUDENTS should be part of NASA's exciting work!